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final report

POSTATTACK FOOD AVAILABILITY AND ACCESSIBILITY --

ALBUQUERQUE, NEW MEXICO

Contract Nos. DAHC-20-68-C0141 and N0022867C150
OCD Work Unit No. 3423A

November 1968

STANFORD RESEARCH INSTITUTE

SRI

MENLO PARK
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Prepared for:

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY
DEPARTMENT OF THE ARMY
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Through:

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NAVAL RADIOLOGICAL DEFENSE LABORATORY
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By:
John W. Billheimer

SRI Project MU-5576
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ABSTRACT

This report is the second in a series of local food distribution studies designed to forecast the availability and accessibility of critical foodstuffs in selected metropolitan areas in a nuclear postattack environment. The analytic technique employed in these studies uses local distribution diagrams, seasonal inventory data, and national production patterns to provide quantitative models of the preattack flow of individual commodities to consumers in the selected areas. Estimates of postattack commodity flow are obtained by applying appropriate damage assessment procedures to critical elements of the preattack distribution models. The application of this technique in the case of Albuquerque, New Mexico, reveals that local citizens might anticipate severe shortages of every important food commodity except potatoes in the period immediately following an attack of the pattern and magnitude considered in this study.

CONTENTS

CONTENTS

CONTENTS

ILLUSTRATIONS

TABLES

I INTRODUCTION

Social and economic recovery following a nuclear attack will depend largely on the availability and accessibility of an adequate food supply. Although a certain amount of research effort (References 8, 41, 57, and 61) was expended before 1965 to determine the relative availability of postattack food supplies, comparatively little thought was given to accessibility. Moreover, most pre-1965 investigations of postattack food availability were primarily concerned with the total calorie content of national food stocks (References 41, 57, and 78). While these nationwide calorie-counting expeditions provided a generally reassuring picture of national food availability, they were not sufficiently detailed to detect either local food shortages or nutritional imbalances in areas top-heavy with calories provided by a single commodity.

In 1965, in an effort to resolve the many unanswered questions regarding local postattack commodity distribution, Stanford Research Institute started a detailed, commodity-by-commodity investigation of food distribution in the five cities of San Jose, Albuquerque, New Orleans, Detroit, and Providence. This investigation is part of a continuing research effort sponsored by the Office of Civil Defense to provide a point-by-point analysis of the effects of nuclear attack on each element essential to the postattack recovery of these five diverse metropolitan areas. These point-by-point analyses are expected to provide a basis for measuring civil defense capabilities, for developing improved national damage assessment techniques, and for evaluating research requirements and results.

The specific long term objectives of these food distribution studies are to estimate the requirements for food to support postshelter activity; to describe analytically local and national patterns of food processing, storage, and distribution; to evaluate the ability of the processing, storage, and distribution systems of selected local areas to meet postattack requirements; and to consider additional facilities or procedures needed to provide food under emergency postattack conditions.

This report, the second in the series of local distribution studies undertaken by Stanford Research Institute, contains an analysis of preattack and postattack food availability and accessibility in Albuquerque, New Mexico. The first detailed investigation of local

food distribution undertaken in this series focused on the preattack and postattack nutritional needs of the citizens of San Jose, California. The results of this investigation are described in Reference 7. The analytic techniques developed and demonstrated in the San Jose study have been refined and reapplied in the study described in this report. Chapter II summarizes these techniques and the results of their application in the case of the Albuquerque standard metropolitan statistical area (SMSA), which is conterminous with Bernalillo County, New Mexico.

II SUMMARY

Method of Analysis

The method of analysis employed in this report is patterned on the network-flow analysis developed and demonstrated in a previous Stanford Research Institute study of local postattack food distribution (Reference 7). This analysis employed local distribution diagrams, seasonal supply graphs, commodity inventory data, and national production patterns to provide quantitative models of the preattack flow of individual commodities from producer to consumer. Estimates of postattack food availability and accessibility were obtained by applying appropriate damage assessment techniques to critical elements of the preattack commodity distribution models.

Preattack Analysis

To support a quantitative analysis of the food distribution system of Albuquerque, New Mexico, data were assembled depicting the location, vulnerability, capacity, and inventory of local producers, processors wholesalers, retailers, restaurants, institutions, and consumers. For local producers, processors, and wholesalers, these data were assembled on a point-by-point basis. The labor requirements of these three elements of the distribution system were assessed, and the locations of critical labor and management personnel were catalogued by census tract. For the remaining system elements, capacity and inventory statistics were summarized by census tracts, and sample structures were used to provide location and vulnerability estimates. Capacity and inventory data were recorded on a commodity-by-commodity basis for the eight food groups of meat, milk, eggs, cereals and cereal products, fruits and vegetables, food fats and oils, potatoes, and sugars. These data were summarized in commodity-flow diagrams that depicted the normal distribution patterns and the location of critical inventories for each food group.

Postattack Analysis

After the commodity flow was determined, it was possible to estimate the effects of the hypothetical attack on the distribution patterns and critical inventories that comprise the flow. In making these estimates, each element of the distribution system, from producer to consumer, was subject to a damage assessment analysis. Existing nationwide damage assessments were used to determine the postattack degradation of out-of-state inputs to the Albuquerque distribution system. Whenever possible, point-by-point assessments were developed and used to estimate the damage suffered by critical distribution elements in and around New Mexico and Bernalillo County.

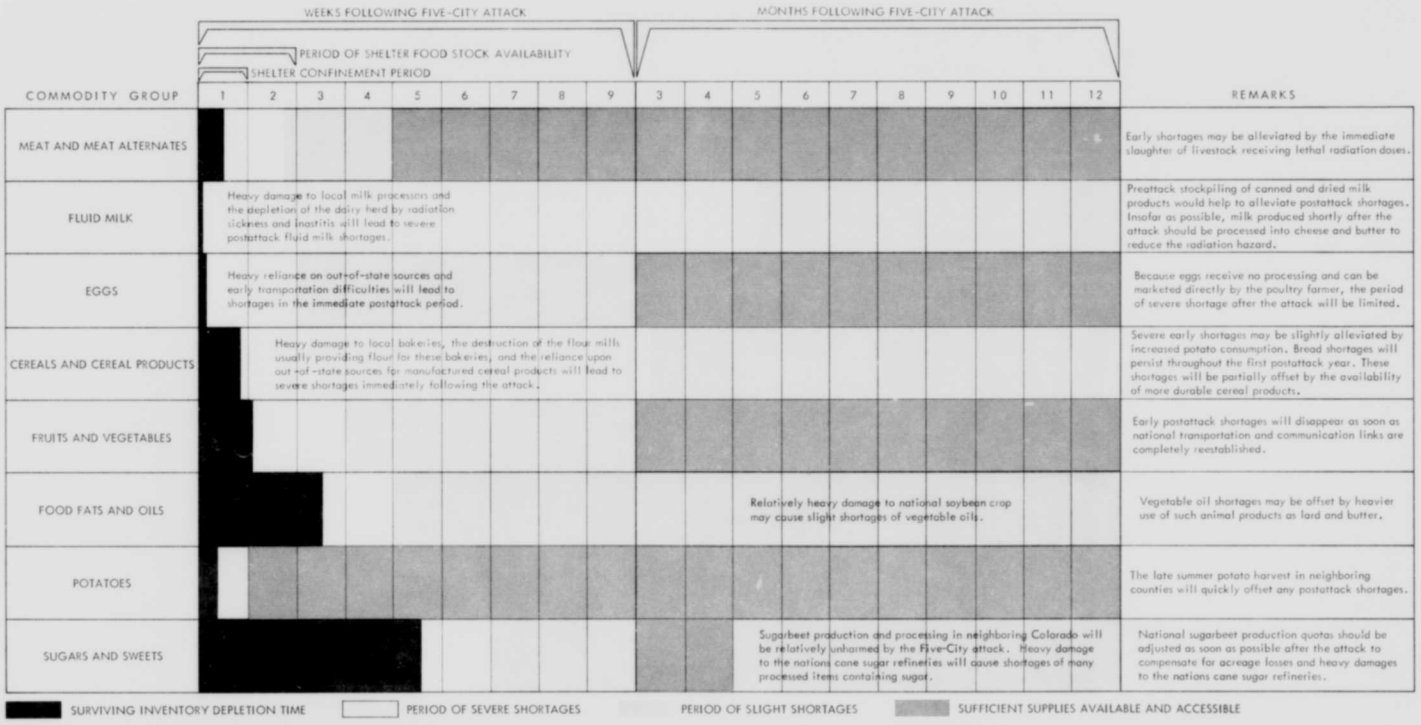
The results of these damage assessments, applied to the local commodity-flow models, were used to predict the probable postattack flow of the selected food groups to Albuquerque survivors. The surviving distribution system was examined for bottlenecks that might be caused by losses in production capability, processing capacity, labor productivity, supply availability, and transportation accessibility. Postattack inventories were compared to the U.S. Department of Agriculture's National Emergency Food Consumption Standards (Reference 93) and the length of time that local supplies of the selected commodities could be expected to meet the requirements of survivors was determined. These periods provided a measure of the time that the sample city could exist as an "island of survival," if isolated from the nation at large.

Albuquerque Results

The network-flow procedures employed in this report provided a useful framework for the analysis of the Albuquerque food distribution system. The results of this analysis are summarized by commodity in Figure 1. This figure shows that Bernalillo County survivors may anticipate severe shortages of every commodity except potatoes at some time during the first five weeks of the postattack period. Meat and egg shortages will exist for a comparatively short period since local production of these commodities can be resumed with relative ease. Local survivors will be heavily dependent on out-of-state transportation connections for supplies of fruits and vegetables, fats and oils, and sugars and sweets. Although severe shortages of these items should not persist for longer than two weeks after the depletion of preattack inventories, slight shortages may be anticipated throughout the first postattack year. Heavy damage to local processors, the depletion of the Bernalillo County dairy herd, and the destruction of the mills that usually provide flour for

Figure 1

SUMMARY OF POSTATTACK FOOD SITUATION--BERNALILLO COUNTY



Albuquerque bakeries will cause severe shortages of fluid milk and cereal products to persist for longer than two months after the attack. It is unlikely that the desirable emergency consumption levels for these items will be attained at any time during the first postattack year.

The rapid disappearance of the working food inventories in Albuquerque's supply pipeline indicates a need for an emergency distribution and resupply capability within the city. Albuquerque's emergency distribution system could be enhanced by stockpiling such critical items as manufactured milk and cereal products at short distances from the city. Without an emergency supply capability beyond that presently available in Albuquerque, however, severe food shortages will be unavoidable in the period immediately following an attack similar to that described in the Five-City Study. Faced with these shortages, local citizens would find it extremely difficult to obtain an adequate nutritional balance during the three to six week period before most preattack supply pipelines are reopened.

III METHOD OF ANALYSIS: PREATTACK

Background

Previous food distribution studies conducted by Stanford Research Institute (References 4 and 8) have used network flow models to predict the effects of nuclear attack on the flow of foodstuffs to attack survivors. These models employed utilization charts, local distribution diagrams, seasonal supply graphs, and various production-consumption time lags as quantitative indicators of the preattack flow of individual commodities from producer to consumer. These quantitative indicators were assigned postattack values by adapting damage assessment procedures to fit existing food distribution data.

The network modeling techniques developed by Stanford Research Institute may be used to describe both national and local commodity flows. This report is chiefly concerned with the local distribution of specific commodities to consumers in a single municipality. National commodity flow is considered only to the extent that it provides inputs to the local distribution system. As in the prototype study described in Reference 7, the major portion of the analytic effort described in this report is devoted to identifying and modeling those distribution elements closest to the local consumer. In addition to wholesalers and retailers, these elements include local producers, processors, restaurants, institutions, and the pantries and refrigerators of the consumers themselves.

Bernalillo County Food Resources

To provide a basis for a quantitative representation of the food distribution system of Bernalillo County, data were assembled depicting the location, vulnerability, capacity, and inventory of each system element. Table 1 summarizes the detail of the data collected. Information regarding element location and vulnerability was assembled for damage assessment purposes, while capacity and inventory data were used to model commodity flow patterns. Capacity and inventory data were recorded for

Table 1

FOOD RESOURCE DATA BASES
BERNALILLO COUNTY

Distribution Sub-Group	Number of Elements	Location Base	Vulnerability Base	Capacity Measure	Inventory Measure
Producers					
Livestock and poultry raisers		Tract-by-tract	Sample livestock	Yearly slaughter	Tract holdings
Crop harvesters		Tract-by-tract	Sample crops	Yearly harvest	Tract holdings
Processors	48	Point-by-point	Individual structures	Yearly individual output	Point holdings
Wholesalers	41				
Food wholesalers	36	Point-by-point	Individual structures	Yearly county throughput	Point holdings
Cold storage warehouses	5	Point by-point	Individual structures	Yearly county throughput	Point holdings
Retailers					
Food retailers	283	Weighted census tract totals	Sample structures	Yearly tract throughput	Tract holdings
Restaurants	216	Weighted census tract totals	Sample structures	Yearly tract throughput	Tract holdings
Institutions	38	Weighted census tract totals	Sample structures	Yearly tract throughput	Tract holdings
Population					
Consumers	333,700	Census tract totals	Sample structures	Yearly tract consumption	Tract holdings
Labor force					
Management	95	Point-by-point	Sample structures	-	
Labor	2,171	Census tract totals	Sample structures	-	

eight commodity groups in those units commonly associated with individual commodity sales. The eight commodity groups considered in this report are listed below:

Meat and Meat Alternatives

Milk

Eggs

Cereals and Cereal Products

Fruits and Vegetables

Food Fats and Oils

Potatoes

Sugars and Sweets

Chapter IV contains a detailed analysis of the local distribution patterns followed by each of the eight commodity groups in reaching Albuquerque consumers. The remainder of Chapter III is devoted to a discussion of the local food distribution system and the data used to support the commodity flow analysis.

Producers

Historically, the lack of rain in New Mexico has limited agricultural production. At present, it is estimated that less than 20 percent of the money spent by New Mexicans for food stuffs goes to buy products produced within the state. This figure is constantly declining, as the total value of the state's agricultural production remains relatively static while the population is increasing.

The composition of New Mexico's agricultural production for the base year 1965 is shown in Table 2. The sale of cattle and calves accounts for more than half of the value of agricultural output. The leading crops are cotton, hay, and sorghum. Hay and sorghum contribute to the food supply indirectly because of their use as feed for meat animals. Food crops have never been produced on any sizable scale by New Mexico farmers, nor are they likely to be so long as the amount of rainfall remains low and the nonfood crops continue to be more profitable.

Table 2

CASH RECEIPTS FROM FARM MARKETINGS BY COMMODITY
NEW MEXICO AND BERNALILLO COUNTY, 1965

Commodity	Value		Percentage of all Commodities	
	New Mexico	Bernalillo County	New Mexico	Bernalillo County
	1,000 Dollars		Percent	
Livestock and Products	170,032	11,835	64.9	93.6
Cattle and calves	138,327	7,940	52.8	62.8
Milk, wholesale	12,751	2,020	4.9	16.0
Sheep and lambs	5,602	185	2.2	1.5
Wool	3,468	10	1.4	0.1
Eggs	4,082	940	1.6	7.4
Hogs	2,437	77	0.9	0.6
Milk, retail	2,200	625	0.8	4.9
Mohair	126	2	*	*
Chickens, farm	142	29	*	0.2
Turkeys	49	4	*	*
Honey	135	2	0.1	*
Beeswax	4	0	0	0
Other	709	1	0.3	*
Crops	91,993	542	35.1	4.3
Field crops:				
Cotton lint	35,565	2	13.5	*
Sorghum grain	10,330	0	4.0	0
Hay	12,862	332	4.9	2.6
Wheat	6,253	11	2.4	0.1
Cottonseed	4,479	0	1.7	0
Onions	3,993	62	1.6	0.5
Broomcorn	1,505	0	0.6	0
Peanuts	1,905	0	0.8	0
Potatoes	795	0	0.3	0
Lettuce	5,183	28	1.9	0.2
Barley	491	3	0.2	*
Tomatoes	279	4	0.1	*
Sweetpotatoes	171	0	0.1	0
Dry edible beans	331	9	0.1	0.1
Alfalfa seed	265	0	0.1	0
Corn	278	10	0.1	0.1
Oats	94	0	*	0
Other	2,827	81	1.0	0.6
Fruits				
Pecans	1,529	0	0.6	0
Apples	960	15	0.4	0.1
Other fruits and nuts	107	11	*	0.1
Other Products				
Greenhouse and nursery	1,046	237	0.4	1.9
Forest	745	1	0.3	*
All Commodities	262,025	12,641	100.0	100.0

* Less than 0.05.

Sources: U.S. Department of Agriculture, Statistical Reporting Service, Las Cruces, N. M., Stanford Research Institute.

The 1965 agricultural output of Bernalillo County is also itemized in Table 2. Just as the sale of beef cattle dominates the state's agricultural output, so it is also the chief source of income for Albuquerque farmers. The agricultural production of Bernalillo County, however, is strongly oriented toward the large Albuquerque market, with a heavy emphasis on such locally consumed items as milk and eggs. In spite of this emphasis, Bernalillo County agriculture fails to produce enough of any single commodity to satisfy even half the demands of county residents.

The disposition of Bernalillo County's agricultural resources is shown on the map of Figure 2. As would be expected, the county's cultivated land borders the Rio Grande River. In recent years, the growth of urban Albuquerque has caused both the number and size of Bernalillo County farms to decrease. This situation may be contrasted with developments in the remainder of New Mexico, where decreases in the number of farms have been offset by significant increases in the size of individual farms. In spite of the decreases in the size and number of Bernalillo County farms, both the amount of irrigated county land and the production of staples for the local market have increased as the population of Albuquerque has increased.

Detailed information regarding the yearly agricultural output of Bernalillo County is published in the 1964 Census of Agriculture (Reference 99). The crop-by-crop and stock-by-stock statistics contained in this reference were assigned to appropriate regions shown on the map in Figure 3 to enable damage assessments to be made. For the most part, these assignments were made uniformly over the areas known to be devoted to cultivation and pasture. In the case of certain large dairy and beef ranches and poultry farms, however, point-by-point resource allocations were made. The harvest-time information appearing in References 35, 96, and 97 was used to determine the seasonal availability of each crop for damage assessment purposes.

Processors

In this 1963 study of food processing in New Mexico (Reference 30) R. B. Goode observed that:

> Most of the food-processing firms in New Mexico are small, serve a local market, and whenever possible obtain their raw materials in this immediate vicinity. Some of the larger firms have a sizeable market area, and these firms typically integrate processing with some raw-materials production (as in the processing of dairy products) or the distribution of their output to retailers or consumers. Raw materials for the larger processors may come from fairly distant points.

Figure 2

AGRICULTURAL RESOURCES OF BERNALILLO COUNTY

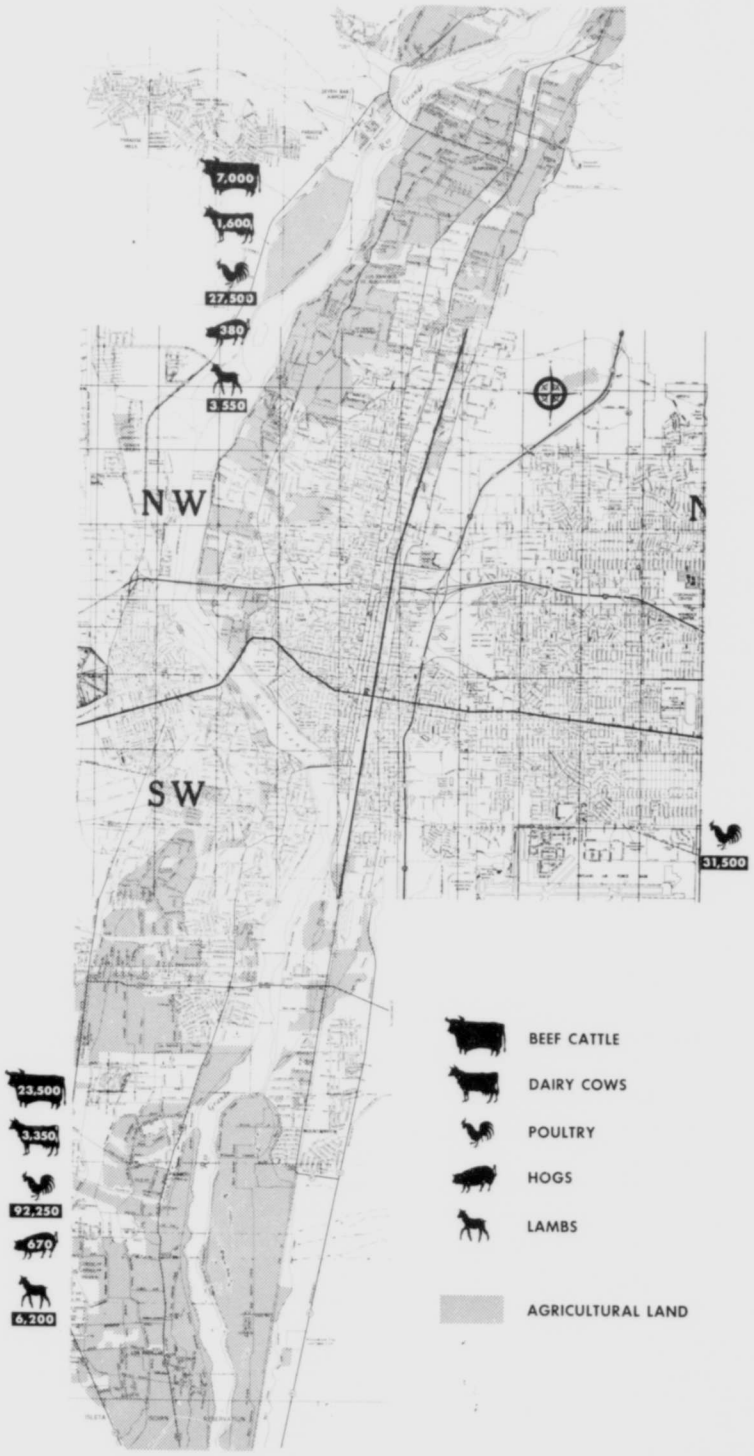
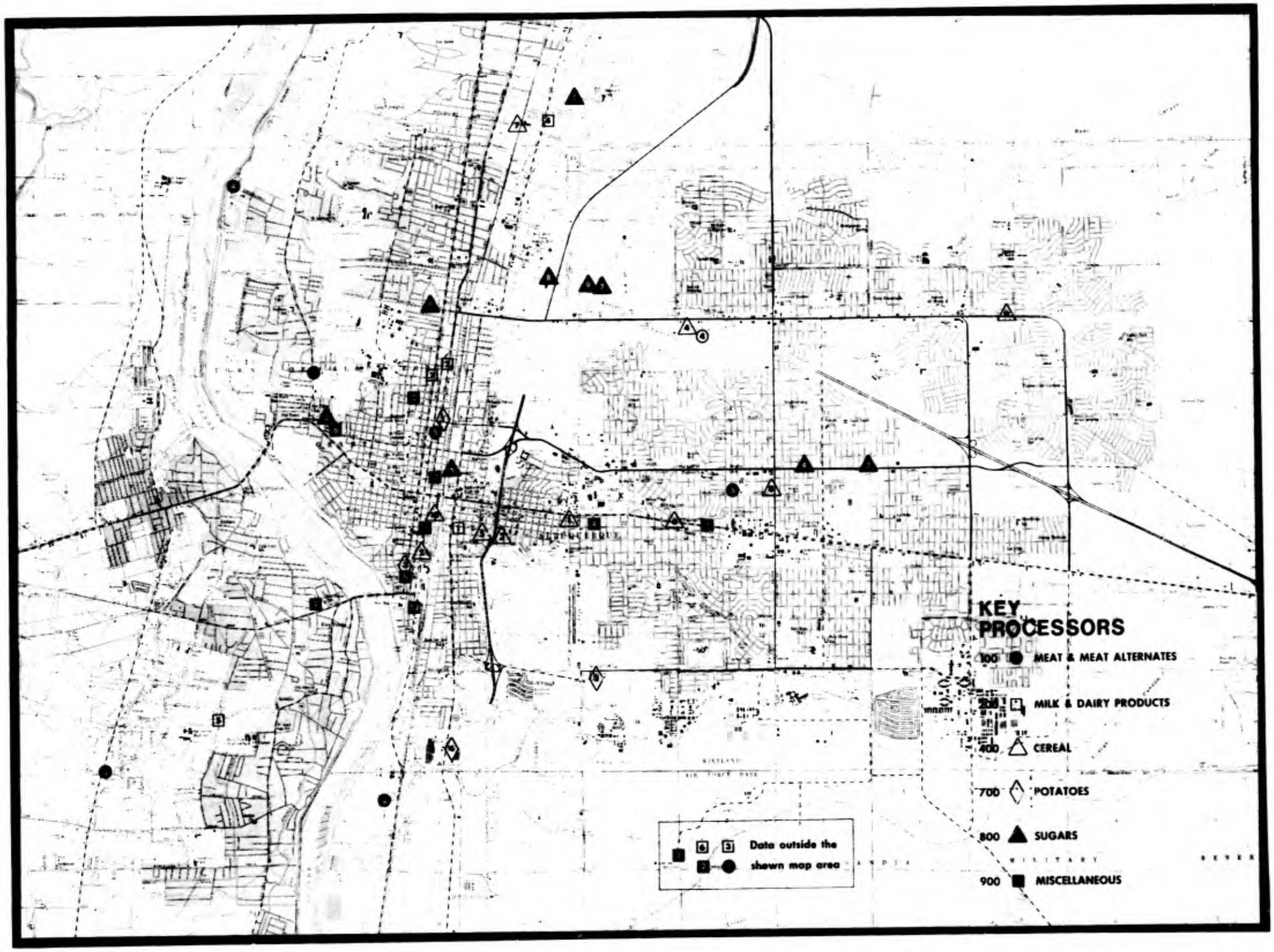


Figure 3

FOOD PROCESSORS OF BERNALILLO COUNTY



The small, local character of New Mexico food processors has changed little since Goode published his study. In the ten years preceding 1965, the number of food manufacturing companies in New Mexico decreased, while the size of individual companies increased moderately to meet the demands of the increasing population.

The largest center of food manufacturing activity in the state of New Mexico is Bernalillo County. The 1963 Census of Manufacturers (Reference 101) reveals that the Albuquerque SMSA contributes 47 percent of the manufacturing value added by the entire state in the processing of food and kindred products. This manufacturing activity is strongly oriented toward the demands of the local market. None of the large Albuquerque food processors have trading areas extending beyond the state boundaries.

Point-by-point data regarding the location of Albuquerque food processors were sorted from such sources as the Dun & Bradstreet Index (Reference 48), state and county manufacturing registers (References 3 and 19), industry directories (References 18 and 16), telephone books, and a partial list provided by the Department of Agriculture Stabilization and Conservation Service. This sorting process resulted in the compilation of a master list identifying 48 food processors in the Albuquerque SMSA. The names and addresses of these processors, arranged by commodity group, appear in Appendix A. The location of each Albuquerque processor is designated on the map of Figure 3.

The proposed network flow analysis also required data detailing each processor's preattack vulnerability, production capability, and inventory holdings. A sample form detailing the total data assembled for each Albuquerque processor appears in Appendix D. Sanborn maps (Reference 34) were used to obtain the vulnerability information required by this sample form. Field visits were made to estimate the vulnerability of buildings not included on these maps.

Data regarding the production capability of the leading processors in each commodity field (as determined by the number of people employed per processor) were obtained by contacting plant managers directly. Estimates of the yearly output of smaller processors were obtained by allocating the total Albuquerque production of a specific commodity to individual processors on the basis of plant employment. These employment figures were readily available in References 3 and 19. A weighting factor was introduced in the allocation scheme to reflect the higher productivity of workers in larger plants. This factor was recalculated for each commodity form under consideration. A similar allocation scheme was sucessfully used to distribute statewide production on a county-by-county basis in the network analysis described in Reference 8. The details of this scheme appear in Chapter IV of Reference 8.

Leading Albuquerque processors that were contacted regarding their plants' production capability were also questioned about their usual inventory practices. Yearly fluctuations were noted, and the August holdings of each processor were recorded in accordance with the Five-City Study scenario. Since it was not practical to contact personally all, or even most, of the processors listed in Appendix A, an allocation scheme that apportioned stocks held by small processors on the basis of warehouse space was devised. This allocation scheme was similar to that described in Reference 7.

Wholesalers

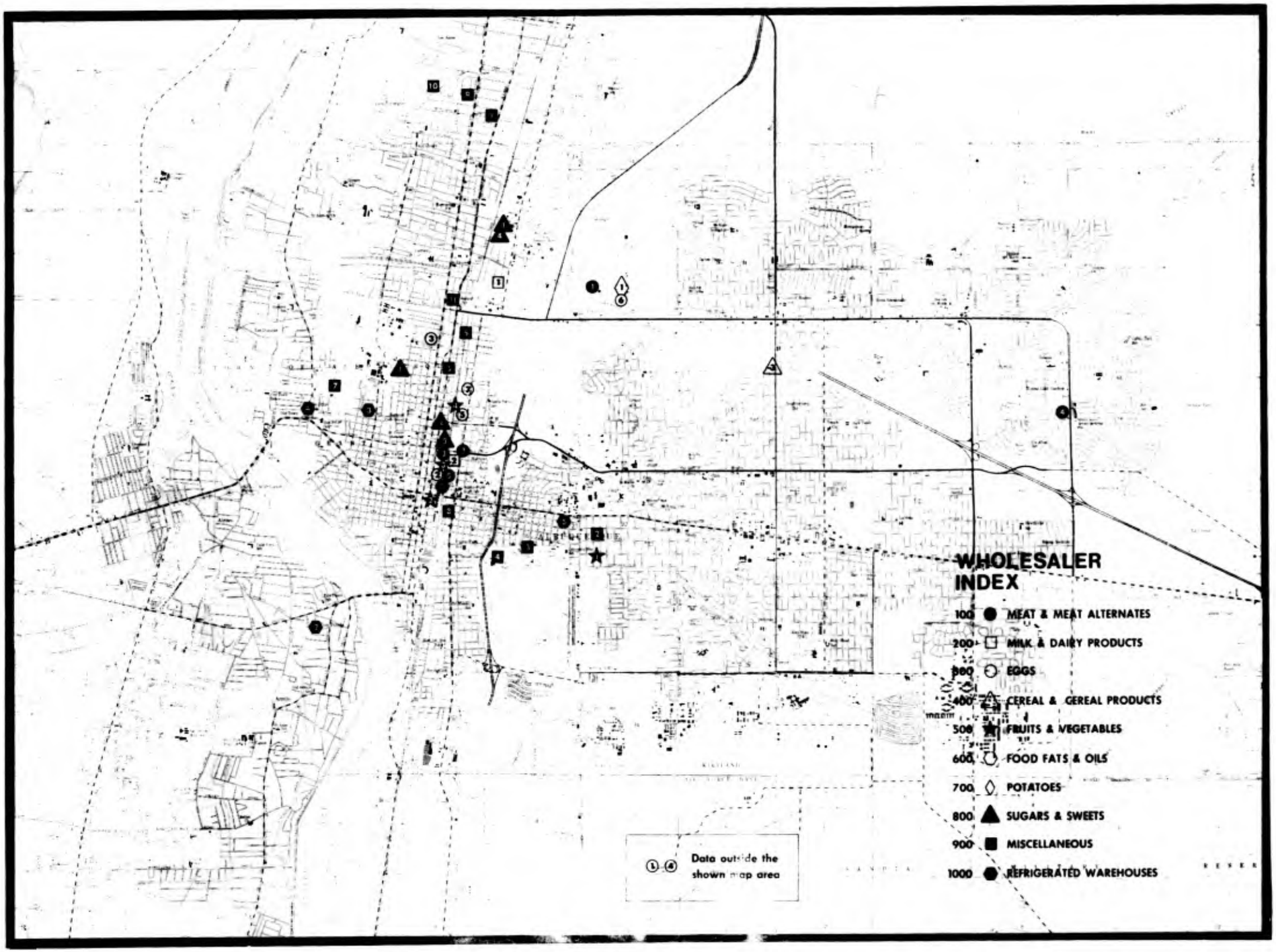
A comparison of the magnitudes of retail and wholesale food sales by New Mexico companies shows that in 1963 retail sales were more than double wholesale sales. This statistic emphasizes the increasing role of out-of-state wholesalers in serving the New Mexico food market. The major reason for the importance of out-of-state food wholesalers in the New Mexico market is that the chain store outlets serving most of the state's population are supplied with a substantial part of their goods by out-of-state firms. In Reference 30, Goode reports that ". . . nearly all of the grocery items sold through chain stores are brought to the New Mexico point of sale from warehouses located in Texas or Colorado, the larger part coming from either El Paso or Lubbock."

Most of those grocery items not sold through wholesale-retail chains reach independent New Mexico retailers through one of six cooperatively owned wholesale houses or through a chain wholesaling company. Five of the six cooperative wholesalers serving New Mexico retailers are located in surrounding states. Both the sixth cooperative wholesaler and the single chain wholesaler have warehouses in Albuquerque.

As might be expected of a city with its population and central location, Albuquerque is the center of food wholesaling activity in New Mexico. Roughly two-thirds of the wholesale food sales made within the state are made through Albuquerque warehouses. Because of the dominance of out-of-state wholesale-retail chain stores in the local market, however, many of the general grocery stocks in Albuquerque warehouses are destined for consumers outside the boundaries of the SMSA. A nationwide survey conducted by the U.S. Department of Agriculture (Reference 78) estimated that the wholesalers of Albuquerque could supply each local citizen with only 4.7 days of food at an emergency consumption level of 2,000 calories per day. By way of comparison, this same survey determined that on a nationwide basis, U.S. wholesalers could supply the entire population with an average of 15.5 days of food at this same consumption level.

Figure 4

FOOD WHOLESALERS OF BERNALILLO COUNTY



Point-by-point data regarding Albuquerque wholesalers were obtained in the same manner as Albuquerque processor data. Such sources as the Dun & Bradstreet Index (Reference 53), industry registers (References 72 and 106), telephone directories, and U.S. Department of Agriculture listings were culled to provide a master list of 41 Albuquerque food wholesalers and cold storage warehouses. The names and addresses of these wholesalers and warehouses appear in Appendix B. The map in Figure 4 shows the location of each Albuquerque wholesaler and cold storage warehouse.

A sample form detailing the total data assembled for each Albuquerque wholesaler and warehouse appears in Appendix E. Sanborn maps and data from field trips were used to provide the vulnerability information required by this sample form.

In the case of the large Albuquerque wholesalers, the inventory information required by the form in Appendix E was obtained by interview. The food stocks of the remaining wholesalers were estimated by apportioning the nationwide commodity inventory statistics published in Reference 86 to Albuquerque dealers on the basis of the annual wholesale sales figures published in Reference 102. This apportionment provided commodity-by-commodity estimates of the total food inventory held by all Albuquerque wholesalers. These estimates were extended to individual dealers by allocating the citywide totals to the smaller Albuquerque wholesalers on the basis of available warehouse space.

Retailers

Retail grocery stores are commonly classified by ownership into two categories: chain stores and independent stores. Chain stores, which are characterized by common ownership of multiple units, are generally larger and more strategically located than independent stores, which usually have one or two outlets and a single owner. In recent years, the proportion of food sales made through large chain stores has been steadily increasing. Reference 8 estimates that less than 6 percent of New Mexico grocery stores are chain stores. Nonetheless, these stores account for more than 40 percent of the groceries sold within the state. In Bernalillo County, the four corporate national chains operating within the county limits are estimated to have had about 80 percent of all food sales in 1965 (Reference 31).

The names and addresses of chain stores and independent grocers in Bernalillo County were compiled through the use of telephone directories and the Dun & Bradstreet Index. These addresses were then used to link each outlet with a particular census tract. The number of corporate chain stores and independent grocery stores associated with each census tract of Bernalillo County is listed in Table 3.

Table 3

DISTRIBUTION OF CHAIN STORES, FOOD RETAILERS, AND ESTABLISHMENTS SERVING FOOD FOR ON-PREMISE CONSUMPTION BY CENSUS TRACT

Albuquerque

Census Tract	Corporate Chain Stores	General Grocers and Independent Retail Outlets	Restaurants and Institutions
1-A	1	5	4
1-B		1	2
1-C	2	13	12
1-D			10
1-E	3	11	7
2-A		2	2
2-B	3	21	29
3	1	4	6
4	5	14	20
5	3	14	57
6-A		5	7
6-B	2	10	30
7			32
8			
9	1	3	8
10			1
11		3	7
12			1
13	1	4	2
14		7	4
15	2	5	11
16	1	3	17
17	2	3	15
18		1	10
19			15
20		3	1
21	1	13	66
22		2	9
23	3	3	19
24		7	27
25		1	3
26	1	8	18
27	1	3	2
28	1	12	17
29		5	8
30		3	2
31		1	
32	2	7	8
33		6	11
34		4	5
35	2	12	17
36			1
37			5
38			
39			
40			1
41		2	
42		1	
43	1	15	7
44		2	2
45		3	1
46	1	3	3
47			3
48			
Totals	40	245	545

Estimates of the total food inventory held by Bernalillo County retailers have been published by the U.S. Department of Agriculture in References 74 and 78. The caloric content of total retail inventory, as estimated by the USDA, would last the Albuquerque population 15.1 days if consumed at a rate of 2,000 calories per day. The commodity-by-commodity breakdown of this inventory may be inferred from a supplemental USDA publication (References 85). Additional information regarding the relative stock levels and turnover rates characterizing retail grocery items are found in a comprehensive study of supermarket sales and margins published by the editors of Progressive Grocer magazine (Reference 52).

Each of the above references was used in estimating the total commodity-by-commodity holdings of the Bernalillo County retail food outlets. In accordance with published sales estimates, 80 percent of these holdings were considered to be equally distributed among the corporate chain stores located within the Albuquerque SMSA. The remaining retail commodity stocks were distributed evenly among the independent grocers of Albuquerque. Because of the census-tract groupings identified in Table 3, this distribution scheme resulted in the assignment of specific commodity inventory figures to each census tract in Bernalillo County.

Restaurants and Institutions

Estimates of the total caloric value of the food stocks held by Bernalillo County restaurants and institutions have been published by the U.S. Department of Agriculture in Reference 73. If consumed at a rate of 2,000 calories daily, these stocks would last 2.5 days, slightly longer than the national average of 1.9 days. A supplemental USDA publication (Reference 84) gives a commodity-by-commodity breakdown of the national food inventory held by establishments that serve food for on-premise consumption and a list of types of establishments surveyed. These establishments are listed in Table 4, together with their percentage share of the total national inventory of 893 million pounds of food held by restaurants and institutions.

Table 4

DISTRIBUTION OF RESTAURANT AND INSTITUTION FOOD STOCKS BY TYPE OF ESTABLISHMENT

Type of Establishment	Percentage of Restaurant and Institution Held Food
Air transportation	1.0
Department stores	1.5
Variety stores	2.2
Eating-drinking places	61.6
Drug stores	6.8
Hotels, motels, etc.	7.3
Private homes for aged, etc.	0.2
Country clubs	1.4
Hospitals	7.5
Colleges	1.5
Fraternal groups, etc.	2.2
Other	6.7
Total	100.0

Source: Reference 84.

Reference 107 also contains distribution figures similar to those given in Table 4 for each of the commodity groups under consideration in this study. To use these figures to estimate the location of Albuquerque's restaurant- and institution-held food stocks, telephone directories and the Dun & Bradstreet Index were used to determine the number and street addresses of the local establishments listed in Table 4. These establishments were grouped by type and assigned to appropriate Albuquerque census tracts. Distribution tables similar to Table 4 were then used to determine Albuquerque's share of the national restaurant- and institution-held inventory and to distribute these commodities among the census tracts of Bernalillo County for damage assessment purposes. The tract-by-tract locations of Albuquerque establishments serving food for on-premise consumption are shown in Table 3.

Population

Consumers. The final link in the Albuquerque food distribution system is the consumer. According to the Five-City Study scenario (Reference 32), 333,700 consumers lived in Albuquerque in 1965. The approximate distribution of this population by census tract is shown in Figure 5.

The U.S. Department of Agriculture publishes annual estimates of the nationwide consumption of individual foodstuffs on a per capita basis (Reference 95). These estimates, weighted by the regional food preferences reported in References 70 and 71, were used to determine the yearly Bernalillo County consumption of each of the eight commodity categories considered in this report. Other USDA publications have attempted to assess the average amounts of food stored by individual consumers (References 78 and 82). Although these publications do not attempt to estimate food storage by individual commodity, they do provide estimates of the length of time that all available consumer stocks could be expected to last under emergency conditions. These estimates, combined with a knowledge of the perishability of various commodities (Reference 2), provide a basis for inferring the commodity-by-commodity make-up of consumer stocks in Bernalillo County. These stocks were assumed to be spread throughout the county in accordance with the population distribution depicted in Figure 5.

Labor Force. A portion of the Albuquerque population not only consumes food but also plays a vital role in the production and distribution process. This portion of the population includes the management personnel and workers in the processing plants and warehouses of the food distribution system. To identify this portion of the population, References 3 and 106 were culled to obtain the names of the general managers of each Albuquerque food processor and wholesaler listed in Appendixes A and B. Personal interviews with the plant managers of the larger Albuquerque processing establishments were used to supplement this list. This process resulted in the identification of 95 individuals responsible for the management of various critical elements of the Albuquerque food distribution system. The residences of the persons identified were located and grouped by census tract. This grouping is presented in Table 5.

To complete the description of the local population's role in pre-attack food distribution, the labor force employed in the local production of food was located by census tract. This location was accomplished by updating the tract-by-tract distribution of workers employed in the manufacture of food and kindred products reported in the 1960 census of population and housing (Reference 104). The updated labor force distribution also appears in Table 5, which catalogues the location of 2,171 food workers by census tract.

Figure 5

BERNALILLO COUNTY POPULATION DISTRIBUTION

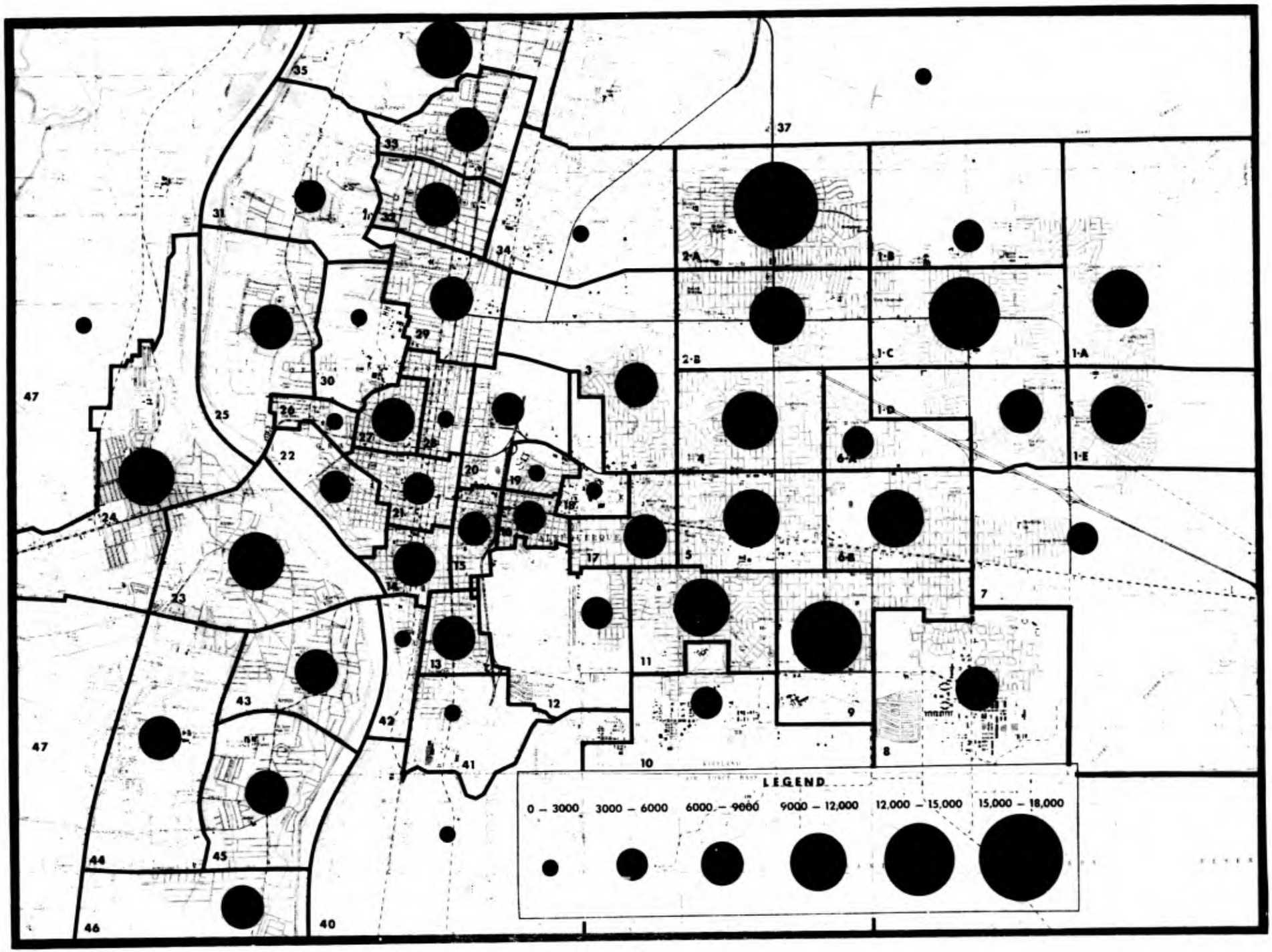


Table 5

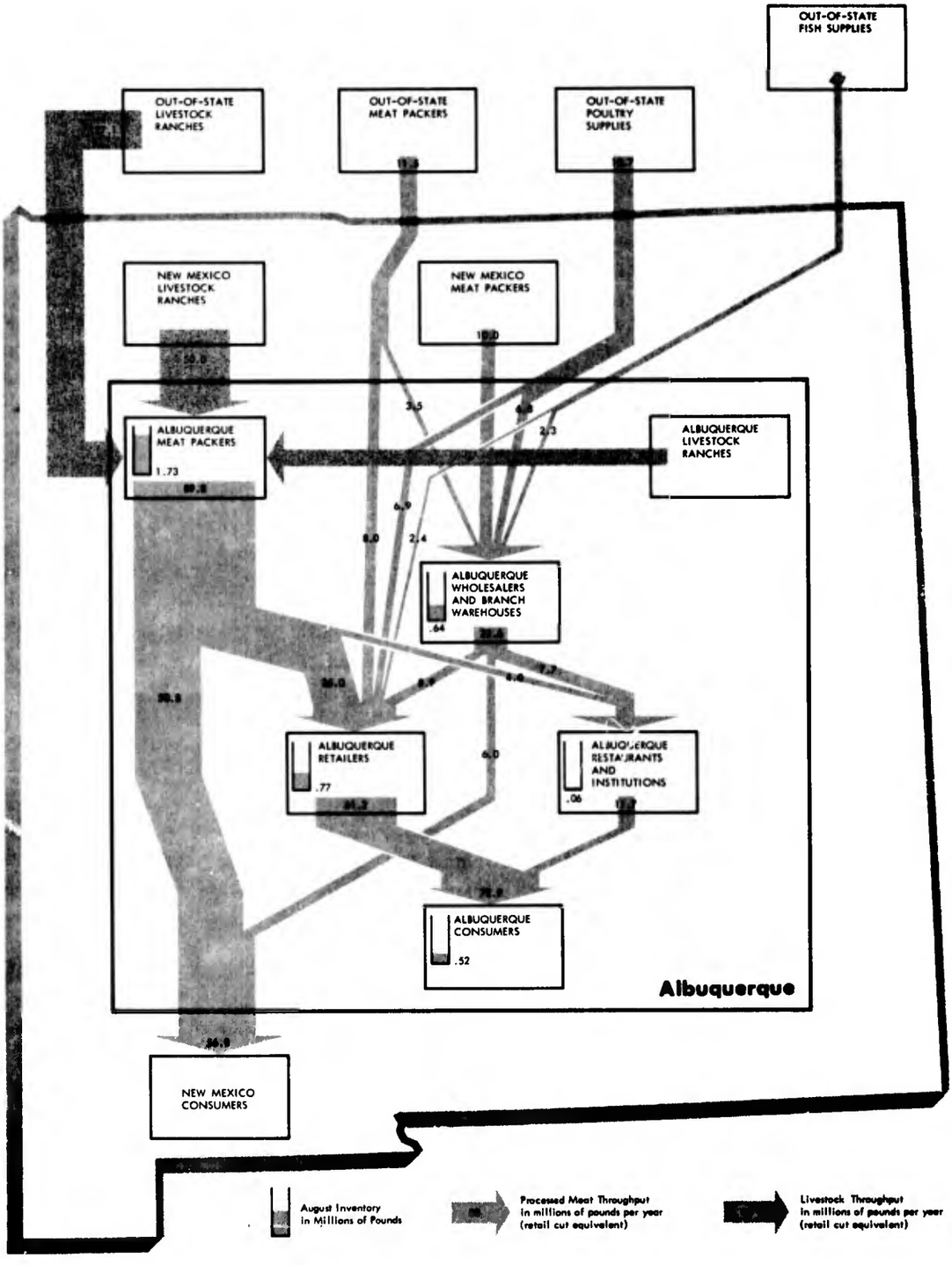
DISTRIBUTION OF POPULATION, FOOD MANAGEMENT PERSONNEL, AND FOOD LABOR FORCE BY CENSUS TRACT

Albuquerque

Census Tract	Total Resident Population	Food Management Personnel	Food Labor Force
1-A	10,600	3	83
1-B	4,200	3	20
1-C	14,000	1	70
1-D	8,900	3	32
1-E	10,400	1	46
2-A	16,900	1	95
2-B	11,200	2	85
3	8,000	7	25
4	11,300	4	60
5	9,200	4	38
6-A	4,600	2	56
6-B	9,200	3	83
7	4,900	2	20
8	8,600	0	5
9	13,200	2	27
10	4,100	1	0
11	11,300	2	75
12	5,700	1	16
13	7,300	1	81
14	7,200	1	78
15	5,500	0	32
16	3,900	2	37
17	7,000	5	39
18	1,700	0	0
19	1,700	0	23
20	4,300	1	11
21	4,800	4	30
22	4,300	2	20
23	9,300	1	72
24	9,700	0	72
25	6,400	1	70
26	3,000	0	27
27	6,100	3	69
28	1,600	4	33
29	7,700	6	67
30	2,100	1	0
31	3,900	1	50
32	7,400	0	60
33	6,100	2	19
34	800	4	0
35	9,300	7	86
36	4,200	0	18
37	1,800	1	14
38	3,800	1	0
39	800	0	0
40	2,200	1	41
41	2,100	0	37
42	2,300	0	18
43	6,900	2	45
44	5,200	1	62
45	7,800	0	34
46	7,000	0	80
47	1,500	1	5
48	700	0	5
Totals	333,700	95	2,171

Figure 6

DISTRIBUTION OF MEAT AND MEAT ALTERNATES IN ALBUQUERQUE



IV PREATTACK COMMODITY DISTRIBUTION

Meat and Meat Alternates

The capacity and inventory data described in Chapter III have been summarized in commodity distribution charts for each of the eight commodities studied in this report. The flow of meat and meat alternates into the hands of Bernalillo County consumers is shown in Figure 6.

Livestock Movement

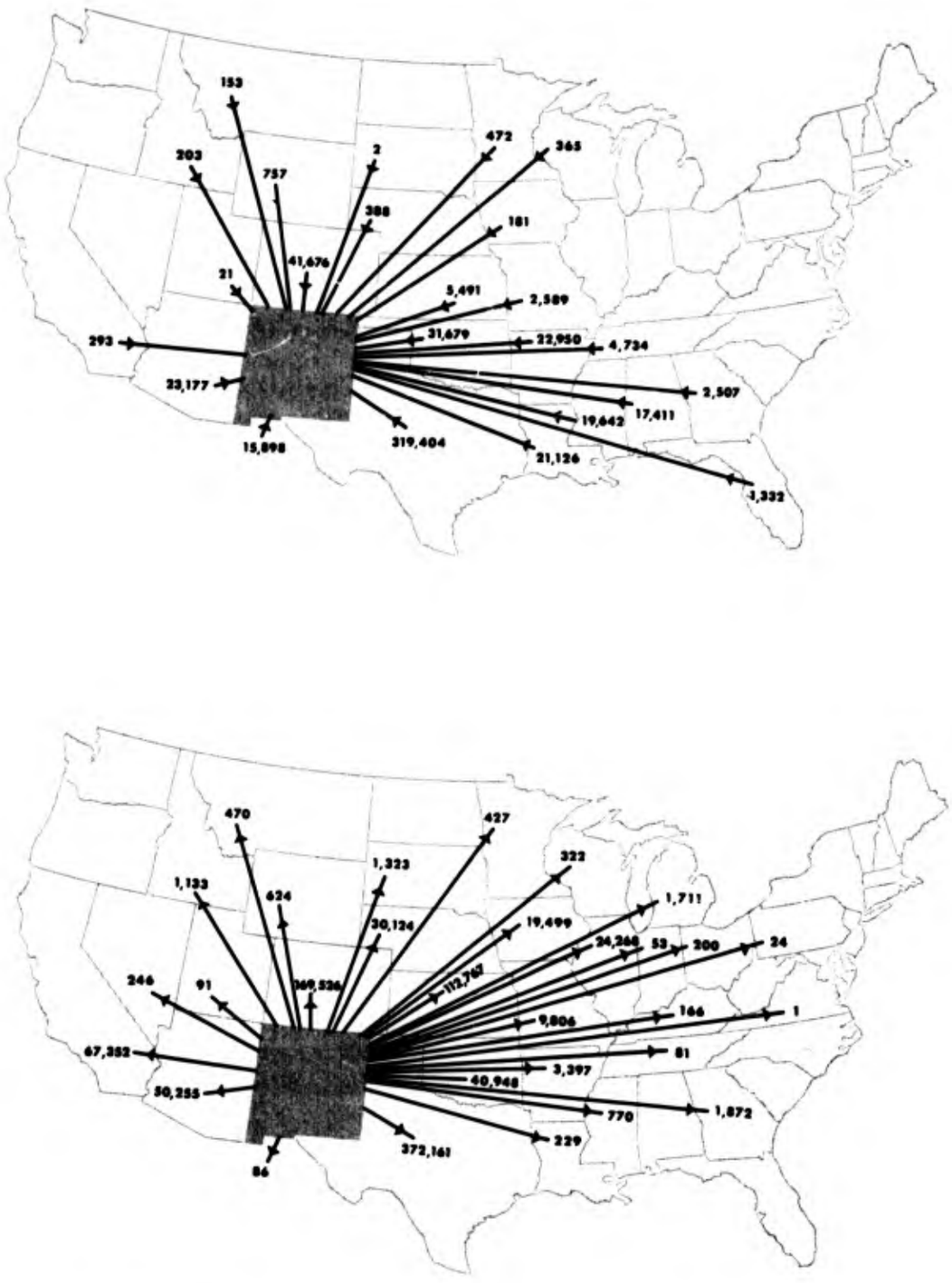
In the past 25 years, the raising of beef cattle has become the dominant agricultural activity in New Mexico. Table 2 has shown that this activity accounted for more than half of the state's agricultural income in 1965. During this year, more than 900,000 head of cattle and calves were sold from New Mexico farms.

The development of commercial feedlots has been an important factor in the recent increase of cattle and calf marketings in New Mexico. In 1965, more cattle were shipped into New Mexico for feeding and breeding than were produced within the state itself. More than three-fourths of the cattle shipped into the state come from neighboring states, with Texas accounting for roughly 60 percent of the total. Shipments out, which may be for additional feeding, winter grazing, or slaughter, go chiefly to these same states, as well as to California and the midwest slaughter houses. A state-by-state breakdown of the origins and destinations of New Mexico livestock movement appears in Figure 7. The movement of cattle into New Mexico generally occurs early in the year, while nearly two-thirds of the shipments out take place in October and November.

Although the raising of stock sheep and lambs has declined in relative importance in New Mexico since World War II, this activity is still sizable. Over 400,000 head of stock sheep and lambs were sold from New Mexico farms in 1965. More than 85 percent of these marketings represented sheep and lambs produced within the state. Shipments out of the state move northward and eastward from New Mexico, with Colorado as the leading destination. Nearly all of the sheep and lambs slaughtered within the state were supplied by New Mexico producers and feeders.

Figure 7

ORIGINS AND DESTINATIONS OF CATTLE SHIPPED INTO AND OUT OF NEW MEXICO IN 1966



SOURCE: Reference 50

Of the three major groups of meat animals, hogs provide the least income for New Mexico farmers. For many years the in-state commercial slaughter of hogs has exceeded the in-state marketings, and recent trends indicate that this imbalance is increasing. In 1965, 97,000 hogs were slaughtered commercially in New Mexico while only 52,000 hogs were marketed by New Mexico farmers. Hogs that are purchased live in the Midwest and transported to New Mexico slaughterhouses make up this deficiency.

With the advent of the superhighway, the motor truck has become the chief carrier of livestock in New Mexico and Bernalillo County. In 1965, truckers accounted for more than 85 percent of all New Mexico cattle shipments. Trucks are also the carriers for a majority of the state's sheep, lamb, and hog shipments. Railroads are commonly used only for certain long distance livestock shipments.

Meat Distribution

Meat Sources. Reference 30 estimates that about a third of the beef sold by New Mexico grocery stores and butchers is slaughtered and processed in the state. This figure nearly doubles in the case of the Albuquerque market, due to the heavy influence of the local packing industry. The balance of the Albuquerque supply comes from national packers and a number of regional slaughtering firms. Principal sources of out-of-state beef are Texas, Oklahoma, Kansas, and Colorado.

Although hog production in New Mexico is relatively small, shipments of live animals and carcasses to New Mexico packers and processors enable these firms to produce about a third of the state's needs. Other pork comes from Texas, Oklahoma, Colorado, Iowa, Minnesota, Kansas, and Nebraska.

Regarding the source of New Mexico's mutton, Reference 30 reports that:

> Of the several types of meat, lamb is the type for which in-state processing comes closest to satisfying the in-state demand. Although New Mexico ranches produce more than enough sheep and lambs to fully meet the in-state consumption, most of the animals are shipped out of the State. Accordingly, some of the lamb consumed in New Mexico is supplied from states to the east and north.

Local Meat Packing. Six of the eighteen meat-packing plants located in New Mexico are found in Bernalillo County. The largest of these six plants dominates the meat distribution industry in the Albuquerque area. This plant specializes in the slaughter of cattle, most of which are supplied by New Mexico farmers. It also slaughters New Mexico-bred lambs, and maintains a cattle feedlot next to its main slaughtering plant. The marketing area served by the plant extends throughout a 230-mile radius of Albuquerque, an area which encompasses most of the state. Most of the deliveries made within this area are made directly to retail stores and meat cutters by trucks owned by the packing house.

Typically, the smaller Albuquerque meat packer is a single proprietorship or a family operation serving the local market. These firms tend to purchase livestock from ranchers in the Albuquerque area and specialize in beef slaughter.

Local Meat Marketing. All local meat packers bypass merchant wholesalers by making deliveries directly to retail outlets. The local marketing of meat products manufactured outside New Mexico is dominated by the leading national meat-packing firms. These major firms also bypass local wholesalers by filling retail orders directly from out-of-state packing plants and branch warehouses. Most shipments are made by truck, but a few large orders are filled by rail. One major meat packer maintains a branch warehouse in Albuquerque.

Poultry Distribution

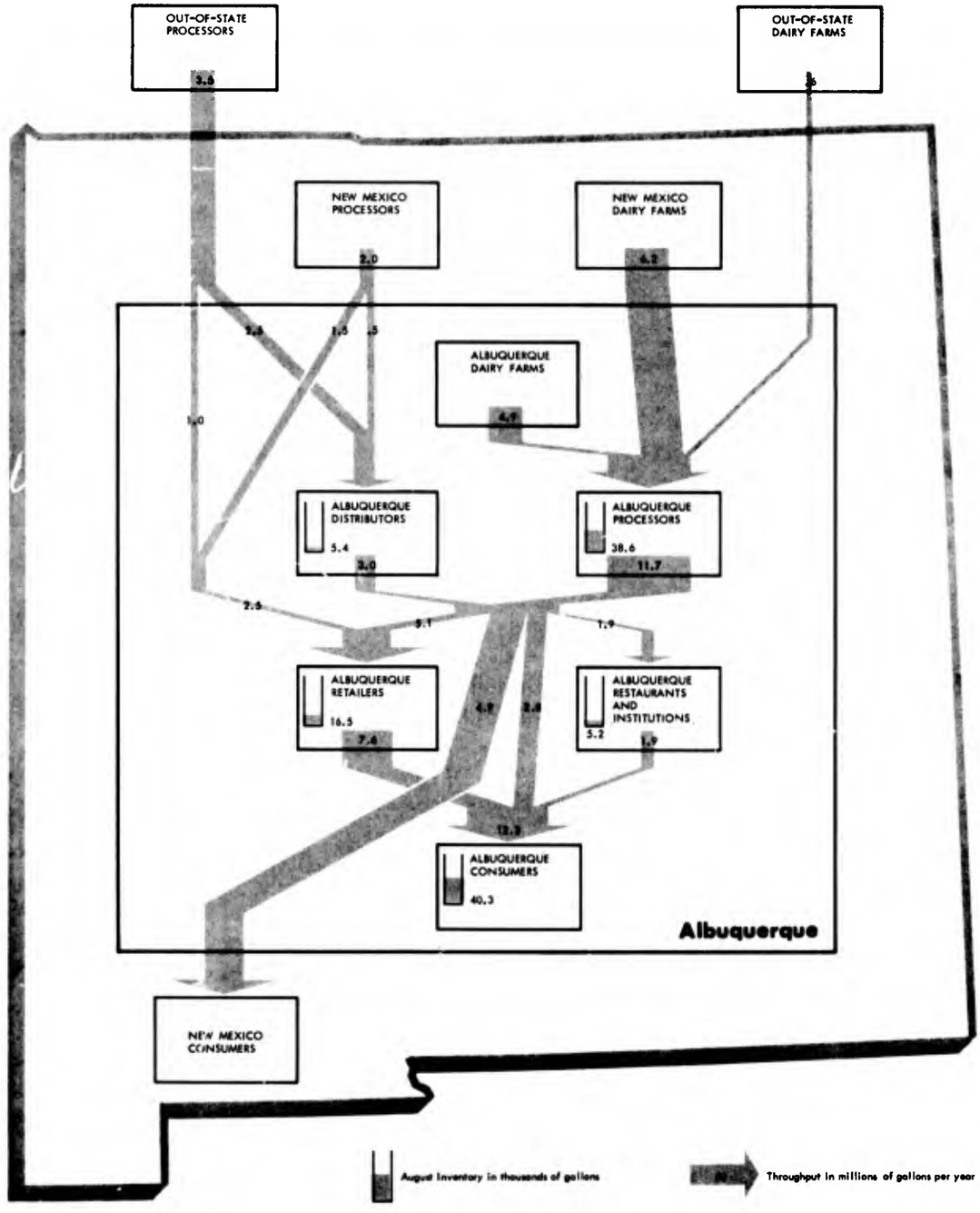
In recent years, yearly poultry consumption in the United States has increased to 41.1 pounds per capita. This figure represents more than a ten-pound per capita increase since World War II. Because broiler production has always been of negligible commercial significance in New Mexico, this increase has not been accompanied by a corresponding rise in state poultry farming. The raising of turkeys and geese is also of minor importance to New Mexico agriculture. Most of the poultry consumed by Albuquerque residents is trucked in from farms in Colorado, Texas, and Arkansas. Much of this supply is shipped directly to the retail outlets, thereby by-passing local merchant wholesalers.

Fish Distribution

The United States, as a whole, consumes an average of 10.6 pounds of fish per capita yearly. More than half of this consumption is imported,

Figure 8

DISTRIBUTION OF FLUID MILK IN ALBUQUERQUE



with Japan being the chief supplier. Fish enter the Bernalillo County distribution system at the wholesale and retail levels and reach the Albuquerque consumer by following the channels indicated in Figure 6. The major carrier of fish within the county is the truck.

Milk and Dairy Products

Fluid Milk Distribution

In 1965, roughly 93 percent of the milk produced in New Mexico was marketed in fluid form. Most of this milk was consumed in areas close to the production point. The flow of fluid milk to the Albuquerque consumer during 1965 is depicted in Figure 8.

Three types of companies dominate the distribution of fluid milk--dairy farms, processing plants, and retail food stores. All three have undergone major structural changes in recent years. Dairy farms have become fewer, larger, and more specialized. Economies of scale have forced many small processors out of business, leaving local markets predominantly in the hands of a few large processors. The rise of the supermarket has made home delivery a secondary source of milk distribution. All of these changes are evident in the distribution system of Bernalillo County.

Farm to Processor Movement. In recent years, both the number of milk cows and the number of dairy farms in New Mexico and Bernalillo County have been steadily declining. At the same time, the total volume of milk produced in both state and county has risen. An increase of more than 25 percent in the per-cow output of milk has more than offset the decline in the number of producing animals. Other compounding factors have led to the dominance of fewer but larger dairy farms. The mechanization of the milking process has reduced labor costs, permitting a fixed amount of labor to be applied to larger operations.

In many instances, the dominance of larger dairy farms may be traced to the inability of the small operator to afford the large initial investment required to keep up with the recent technological advances in dairy farming. One such advance is the introduction of bulk handling methods in farm milk storage and transportation. These methods require that milk be delivered directly from the milking machine into large, sterile, cooled tanks. The cooled milk is periodically pumped from these farm tanks into bulk-type tank trucks, which deliver it to local processors. The use of bulk tanks, rather than ten-gallon cans, in farm storage both reduces handling costs and makes possible the delivery of higher quality milk. The

relatively high initial investment required for these tanks, however, has placed many of the small dairy farms of New Mexico at an operating disadvantage.

Most of the milk produced on New Mexico dairy farms is transported in bulk to nearby processors and dealers. Reference 30 notes that the Roosevelt County region along the state's eastern border is the only sizable area where total output exceeds local demand. Much of this excess milk now moves into the larger cities of north and west Texas and southeast New Mexico. Bernalillo County has the second highest production and sale of wholesale milk of all New Mexico counties.

Processor to Retailer Movement. Milk destined for use in fluid form must be pasteurized and put into suitable containers before being delivered to the consumer. Each processing step requires a large investment in equipment, but little in manual labor. Because of the high fixed costs of these steps, the fluid milk processing facilities in a given area tend to be concentrated in a small number of companies. As an example, the two largest Bernalillo County milk processors are responsible for more than 90 percent of the milk production within the Albuquerque SMSA.

Most of the milk processed in Albuquerque comes from the immediate vicinity of Bernalillo County. One of the two large local processors maintains his own dairy herd, while the other relies exclusively on New Mexico dairy farms. Out-of-state milk is required by local processors only during the school year, when school milk programs make demands exceeding the capacity of New Mexico farmers.

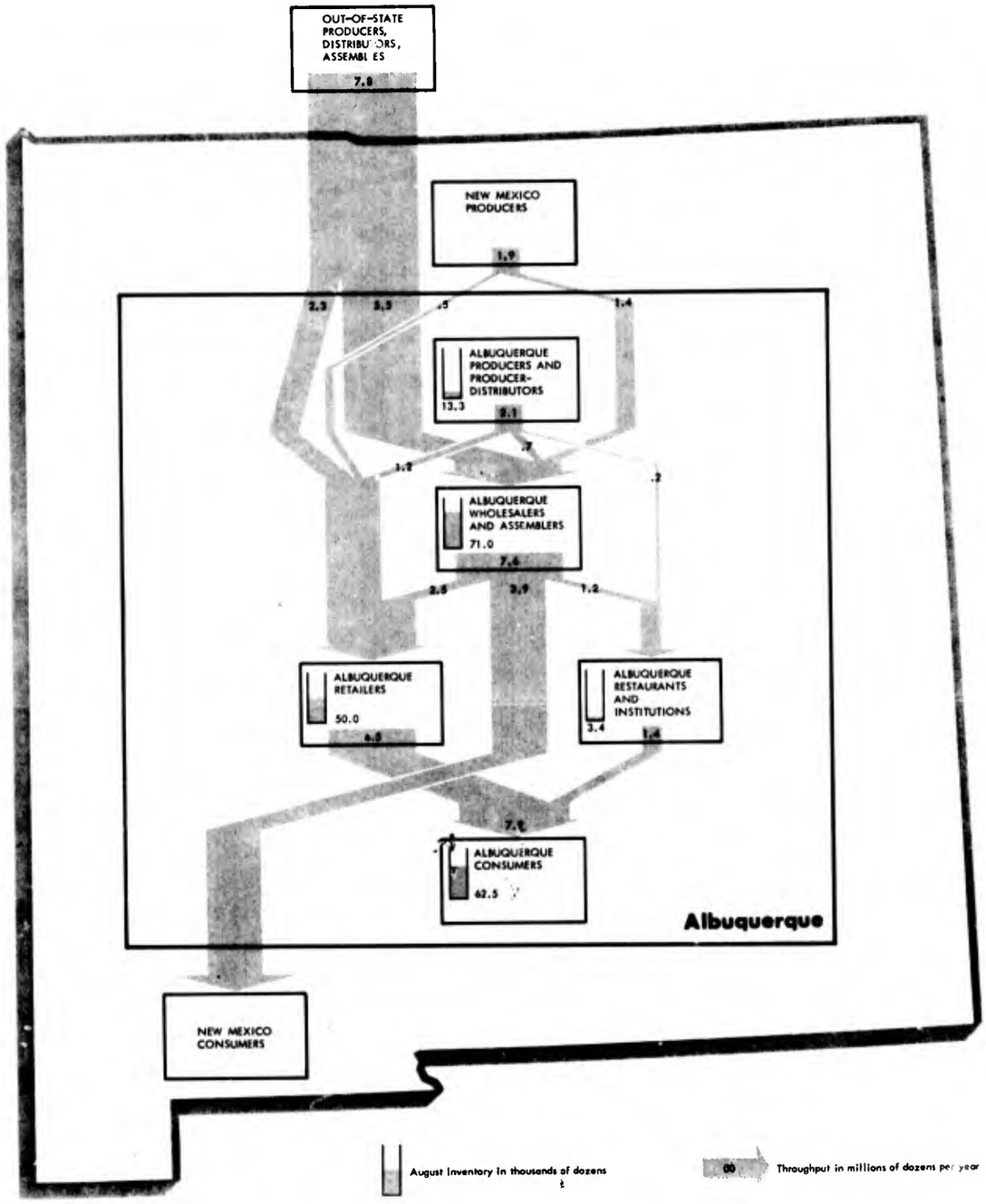
Markets for the largest Albuquerque processors extend throughout the state of New Mexico. As would be expected, however, their heaviest demands come from consumers located within the Albuquerque SMSA itself. These processors serve their local and state-wide markets by truck through deliveries directly to consumers' homes and to retail stores.

The smaller Albuquerque milk processors combine processing and distribution with the operation of a dairy herd. The market served by these firms is limited to the local area and is served through processor-owned retail outlets, retail routemen, and independent grocers.

Local processors share the Albuquerque milk market with out-of-state firms operating through retail chain stores. These firms sell surplus milk from areas quite distant from Albuquerque under private brand labels in the city's nationally affiliated supermarkets.

Figure 9

DISTRIBUTION OF SHELL EGGS IN ALBUQUERQUE



Retailer to Consumer Movement. Once pasteurized and bottled or cartoned, fluid milk may be delivered to the consumer through either of two principal marketing channels. The first is direct delivery to the consumer's doorstep, usually on alternate days. The second channel uses wholesale routes to retail grocery outlets. Thirty years ago, 70 percent of the fluid milk consumed in the United States was delivered directly to the home. In recent years, however, the rising popularity of the supermarket has cut the percentage of home-delivered milk in the Albuquerque SMSA to 23 percent of the total amount consumed.

Manufactured Milk Products

Manufactured milk products include butter, cheese, ice cream, and condensed, evaporated, and dried milk products. Nearly 50 percent of the total amount of milk produced in the United States in 1965 went toward the production of these products. The relative amount of milk devoted to butter production in the United States has decreased sharply in the last 25 years. The amount used in such manufactured products as cheese, ice cream, and evaporated and dried milk, on the other hand, has shown a corresponding increase. Sales of low-fat milk derivatives in both dried and liquid form have increased much more rapidly than those of whole milk.

The only manufactured milk product produced on a sizable scale in New Mexico is ice cream. Most of the ice cream consumed in Albuquerque comes from in-state processors. The leading exceptions are private-label ice cream retailed by chain stores and ice cream produced in neighboring states and sold through local branch wholesalers.

The commercial production of butter in New Mexico is insignificant. The distribution of this product within Albuquerque is discussed later in this chapter in connection with the distribution of food fats and oils.

Cottage cheese is the only form of cheese produced in New Mexico. Chain stores that are supplied by their out-of-state warehouses are responsible for most of the local cheese distribution. Independent retailers obtain national brands of cheese through either a general line grocery wholesaler or a speciality foods wholesaler. All other manufactured dairy products enter the Albuquerque distribution system at the wholesale and retail levels through branch wholesalers and chain-owned supermarkets.

Eggs

In both the United States and New Mexico, the marketing of eggs has undergone rapid and substantial changes since World War II. These changes

have been caused by demand shifts and significant advances in production and marketing technology.

Marketing Channels

As eggs move through marketing channels, various marketing functions may be performed by several different kinds of companies. In the simplest channels, eggs move directly from producer to consumer. A more complex marketing network might find producers, buying stations, country assemblers, wholesalers, and retailers all handling the eggs before they reach the consumer. In the most common process, eggs are assembled from producers by assembler-shippers that ship in truckload lots (600 or more 30-dozen cases) to wholesale distributors. These companies sell to a variety of outlets, the most important of which are food chains and independent retailers. Recently, large volume producer-distributors have assumed the function of assembler-shippers. A tendency is growing, particularly in New Mexico, for the producer-distributor to serve individual retailers directly. The marketing channels serving Albuquerque consumers are depicted in Figure 9.

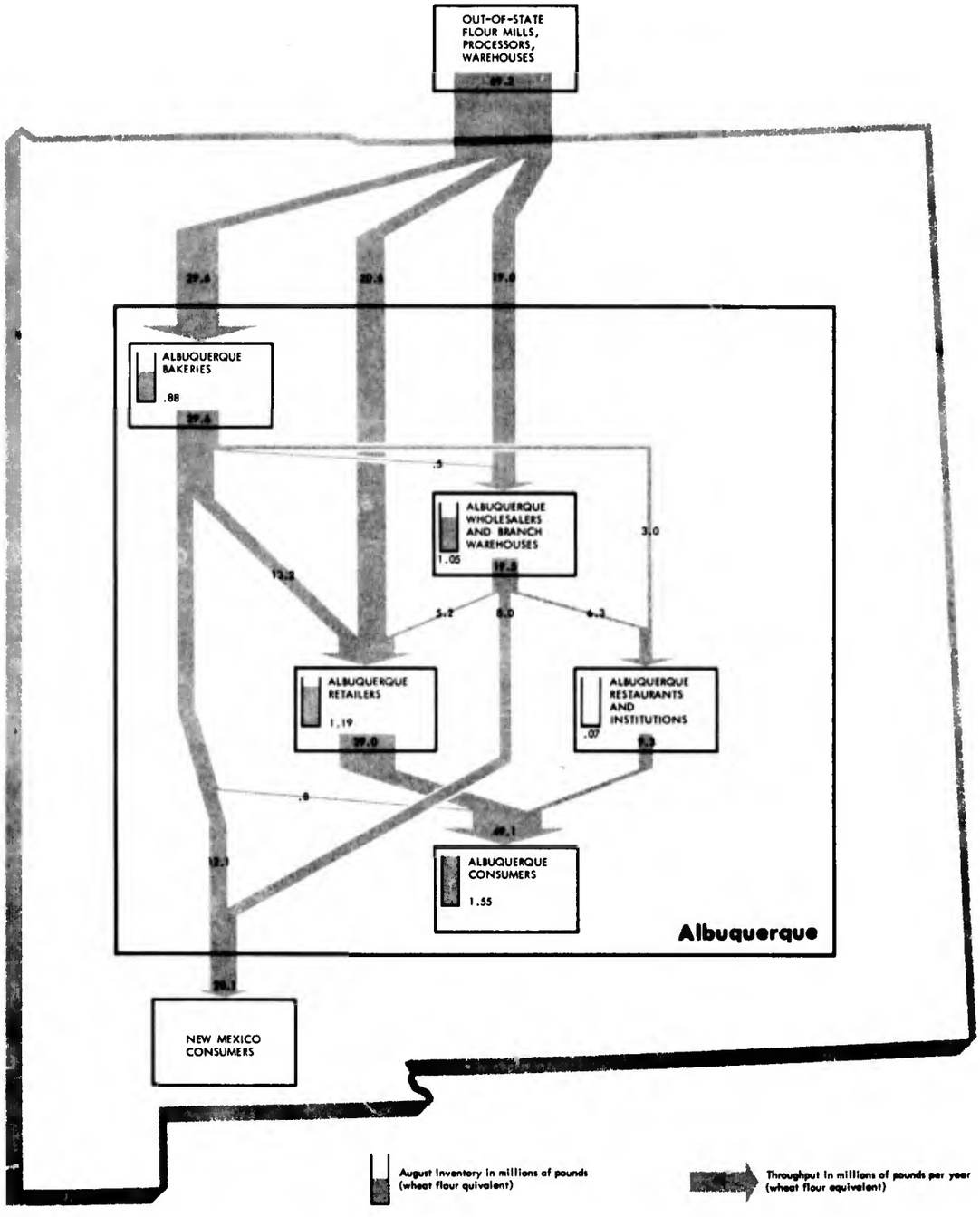
Production-Consumption Characteristics

Egg production in the State of New Mexico quadrupled in the years between 1949 and 1965. During the same period, the number of farms selling eggs commercially fell to one-eighth of the 1949 number. These statistics indicate the growing importance of the large-scale producer in the New Mexico egg market. The leading New Mexico county in terms of egg production is Doña Ana, which is located across the Texas border from El Paso. As most of the eggs produced in New Mexico are sold in the vicinity of the producing farm, much of this county's egg production remains in the El Paso area. Bernalillo County is second to Doña Ana County in New Mexico egg production.

In spite of the recent increases in New Mexico egg production, in-state egg production has never been sufficient to meet the in-state demand. A substantial part of the Albuquerque egg market is supplied by out-of-state sources. Historically, these sources have been located to the east. Recently, however, California egg producers have entered the Albuquerque market. The distribution routes of out-of-state eggs differ greatly; they may move through local meat dealers, specialized wholesalers, or chain stores that are supplied by out-of-state warehouses. Most local egg production is wholesaled by the producer himself.

Figure 10

DISTRIBUTION OF CEREALS AND CEREAL PRODUCTS IN ALBUQUERQUE



Manufactured Egg Products

Roughly 9 percent of the eggs produced in the United States are used in manufactured egg products. This percentage represents an annual per capita consumption of 29 eggs. The Midwest is the chief egg breaking and drying area in the United States. Most manufactured egg products consumed in Bernalillo County come from this area. These manufactured products enter the distribution system at the processor level. The largest user of manufactured egg products is the baking industry, with the premix and confectionery industries second and third. The form of the product used varies among these three industries. Bakeries prefer frozen eggs, while the premix industry relies almost exclusively on dried products. Confectioners use over 60 percent of their egg products in liquid form.

Cereals and Cereal Products

The distribution of cereals and cereal products in Bernalillo County is depicted in Figure 10.

Wheat Marketing

Wheat is the most important cereal crop raised in the United States. As the national bread crop and one of this nation's chief agricultural exports, wheat is exceeded in dollar value of yearly harvest only by cotton. Unlike most cereal grains, wheat is used principally for human food. As such, it provides nearly 20 percent of the food energy of the national diet. Most of the wheat destined for human consumption is milled to produce flour for use in making bread and other bakery products. A much smaller proportion of the annual harvest is converted into breakfast foods and such edible pastes as macaroni and spaghetti.

Wheat is moved from the producer to the flour miller through a number of marketing agents and storage facilities. Harvested wheat may be hauled directly to a country elevator, or it may be stored on the farm before marketing. In any case, the commercial marketing of the yearly wheat crop usually begins at local country elevators. These local storage facilities generally have a capacity ranging from 20,000 to 30,000 bushels of grain.

When the country elevators have accumulated a substantial volume of grain, the wheat is most often shipped to terminal elevators. Alternatively, local elevators may deliver their grain directly to flour mills or make it ready for export. Whatever its destination, most of the wheat shipped from country elevators travels by rail.

Terminal elevators, located in the important milling centers of the country, provide the large storage reservoirs necessary in the grain marketing channels. These elevators range in capacity from 300,000 to 10 million bushels. Besides substantial storage capacity, terminal elevators provide facilities for weighing, inspecting, drying, cleaning and marketing grain.

Wheat production in the State of New Mexico has always been intermittent. The lack of adequate rainfall has prevented this crop from becoming a reliable income producer for the state's farmers. In 1965, less than one-half of one percent of the total United States wheat crop came from New Mexico. The leading wheat producing counties in New Mexico are Curry, Roosevelt, and Quay, all of which are located along the state's eastern border. Most of the wheat from these counties eventually reaches terminal elevators in Amarillo and Lubbock, Texas. Since virtually no wheat is produced in Bernalillo County, and the New Mexico wheat crop moves away from Albuquerque into Texas, there are no substantial wheat storage facilities in Bernalillo County. Wheat entering the county distribution system, therefore, is usually in the form of flour.

Flour Milling

Most of the wheat stored in country and terminal elevators eventually moves by rail to a flour mill. On arriving at the mill, wheat is weighed, cleaned, dried, and then stored in large concrete bins. Most mills store at least a six weeks' supply of raw wheat. As grain is needed for milling, wheat is drawn from this supply and subjected to another cleaning process. The wheat is then conditioned and milled into flour and its by-products.

As a general practice, millers prefer to ship flour within a few days of its production. Most flour is shipped by rail, some over relatively long distances, since most of the 800 flour mills in the United States are located close to the wheat crop.

New technology has made it possible for these relatively few large flour mills to produce enough flour to meet all domestic requirements. Consequently, no millers are located in Bernalillo County. In fact, no millers of any consequence are located in the entire state of New Mexico. Those mills which do exist in the state concentrate primarily upon the production of livestock feeds and produce flour only as a secondary item. The market for this by-product flour is largely local. The Albuquerque flour market is served almost exclusively by out-of-state millers.

Bread Production and Distribution

More than half of the flour milled in the United States is channeled into the production of baked goods. Most of this total is used in the baking of bread and related products for immediate consumption. It is estimated that bread accounts for about 69 percent of the total quantity of bakery products produced in this country and 52 percent of their total value (Reference 26). Bread-type rolls and sweet yeast goods represent an additional 18 percent of the total quantity of bakery production and 22 percent of the total value.

The chief ingredients of bread are wheat flour, shortening, water, yeast, sugar, and salt. These ingredients are combined with various flavoring and enriching additives in large electrically operated mixers. The dough is then fermented and mechanically kneaded, shaped, and panned for baking. When ready for baking, the dough is conveyed to an automatic oven where heat is applied steadily for 20 to 30 minutes. The bread is then cooled, sliced, and wrapped for delivery. In modern bakeries the entire operation may be completed in eight hours or less. Moreover, the recent development of prefermented yeast solutions may greatly speed this process.

Bread will begin to grow stale about three days after baking. Because of its perishability, therefore, it is essential that bread be delivered to a retail outlet as soon after baking as possible. In Bernalillo County, this delivery is made by truck.

One-third of the bakeries in New Mexico are located in Bernalillo County. In 1963 these establishments were responsible for two-thirds of the manufacturing value added to bakery products in the entire state. In general, there are two types of bakery firms operating within the Albuquerque SMSA. Reference 30 characterizes these two types of firms as follows:

> First, there are the large, high volume firms selling their products over a large area. Extensive promotion is used by these producers. The other class consists of smaller firms, which usually have a more limited market area, a larger product line, and typically engage in little, if any, extensive distribution. Often the smaller firms conduct their baking activities in conjunction with retailing, either at a fixed location or from vehicles traveling residential routes.

Three of the ten bakeries located in Albuquerque may be classified as large, high volume firms. Two of these firms specialize in bread and buns and produce few pastry items. The third firm relies more heavily on pastry production. All three firms use mass production techniques extensively. The market areas for all three firms are large--in one case

extending over the entire state--and deliveries are made frequently. Because of the size of the market areas, transportation costs are considered to be quite high, and distributing the product to the market is a major part of each bakery's total operation.

The large Albuquerque baking operations obtain most of their flour from Denver by tankcar. The general practice is to order a shipment of flour every two weeks. Local bakeries are unable to store more than a three-week supply of flour because of the possible presence of weevil eggs that have a twenty-one day gestation period. Some shortening for baking purposes is purchased from New Mexico meat processors, but important amounts are imported from out-of-state sources to the east and north. Common practice among the large operations is to maintain a month's supply of shortening, sugar, and milk solids at the bakery site.

According to Reference 30, the small bakeries of Albuquerque:

> . . . are characterized by a small market area (sometimes only a neighborhood), a broad variety of products, and sales through a limited number of outlets. Often the accompanying retail outlet is the only form of distribution. Other small firms distribute through retail groceries in their locality. Some of the small firms are large enough to buy flour in carload lots from milling points. Most, however, rely on the wholesalers in the vicinity to provide them with supplies.

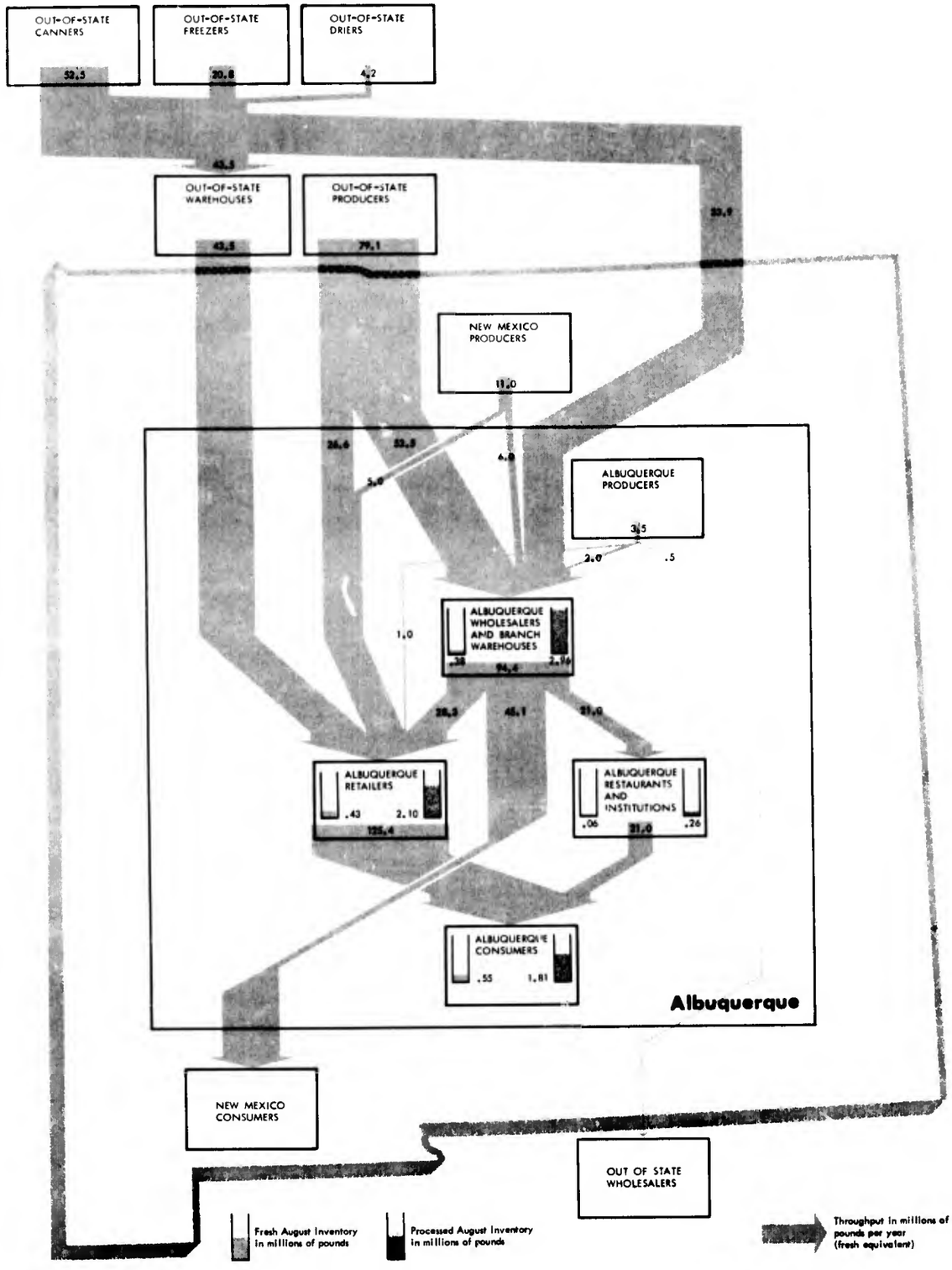
Miscellaneous Cereal Products

In addition to bread and related products, manufacturing bakeries in the United States annually produce more than eight billion pounds of biscuits, crackers, cookies, ice cream cones, and pretzels. The four basic stages in the manufacture of these items--mixing, oven-feeding, baking, and packaging--have been almost completely automated in recent years. Although the four largest producers in this field have captured 62 percent of the market, there is much local and regional competition for the remaining share. However, no large producers of biscuits, crackers, cookies, and so forth exist in the Albuquerque SMSA. Hence, these items enter the Bernalillo County distribution system at the wholesaler and retailer levels. Because these items are generally less perishable than bread, they tend to follow ordinary grocery marketing channels in reaching the consumer.

Little regional competition exists in the breakfast food industry. The six largest manufacturers of breakfast cereals in the United States hold almost all of the market and distribute their products nationally. These products enter the Bernalillo County distribution system at the

Figure 11

DISTIBUTION OF FRUITS AND VEGETABLES IN ALBUQUERQUE



wholesale and retail levels. Similar marketing patterns are followed by other manufactured cereal products.

Fruits and Vegetables

Because of climatic uncertainties, the commercial production of fruits and vegetables has never played an important role in New Mexico agriculture. Vegetable production in New Mexico accounts for only a small portion of the state's farm income and for less than one percent of the total national vegetable production. Fruit production is even less significant on a local and national scale. Consequently, most of the fresh produce purchased by Albuquerque consumers comes from out of state. Because of the scarcity of fresh produce, moreover, the state's fruit and vegetable processing industry is insignificant. The marketing channels followed by both fresh and processed fruits and vegetables in reaching Albuquerque consumers are shown in Figure 11.

Fresh Distribution

Most of New Mexico's commercial fruit and vegetable production is directed into the fresh produce market. This market is dominated by a sense of urgency brought on by the uncertainties of weather, the perishable nature of the products, and the fluid nature of the markets. Harvests must be moved to market within short time periods. Crops vary from year to year and season to season. The seasonal nature of the crops produced in New Mexico and Bernalillo County is indicated in Figure 12.

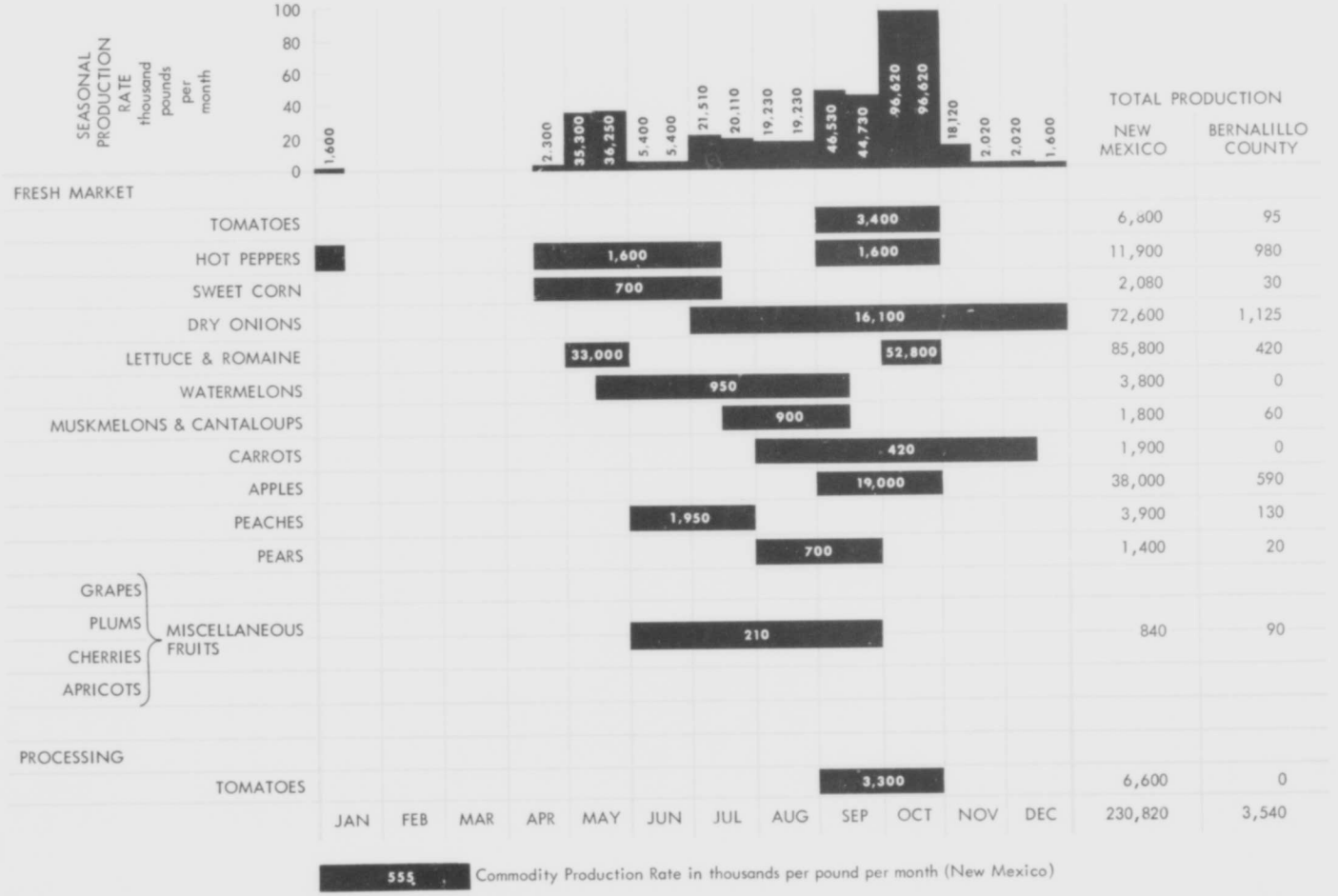
Most of the fruit and vegetable production indicated in Figure 12 is distributed locally by truck. The only two crops distributed nationally in significant quantities are onions and lettuce. Portions of these crops are shipped by rail to distant markets in the eastern half of the United States. Seasonal markets in adjoining states are served by truck.

New Mexico crop farmers are able to satisfy only 15 percent of the demand for fresh produce in Albuquerque. Much of this supply comes by truck from nearby Valencia county. In recent years there has been an increasing tendency for local retailers to purchase produce directly from the growers. Independent Albuquerque retailers tend to deal with local growers, while the larger chain stores contract direct shipments from out-of-state produce farmers.

In spite of the growing tendency for retailers to deal directly with growers, the specialized produce wholesalers in Albuquerque still command

Figure 12

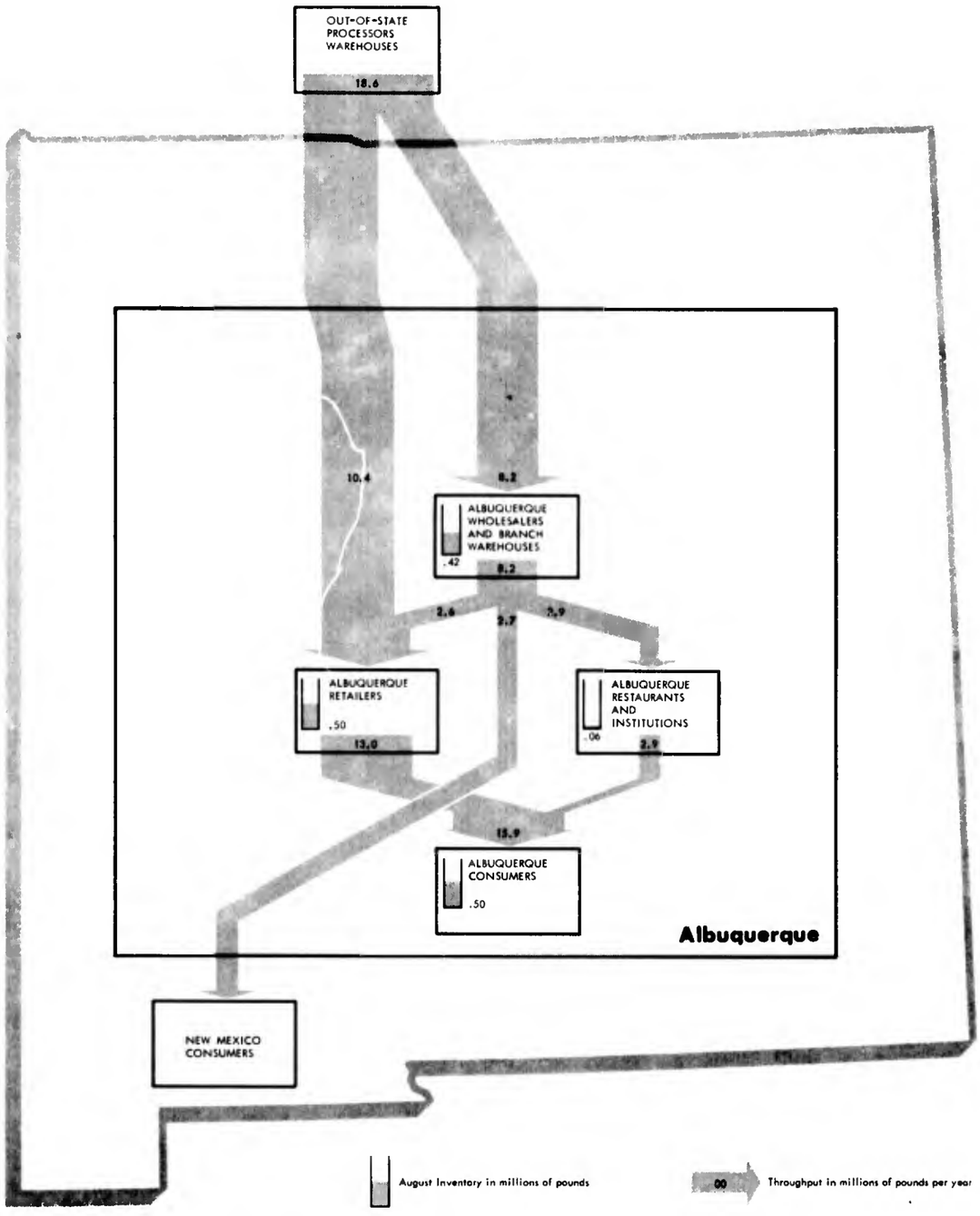
FRESH FRUIT AND VETGETABLE PRODUCTION IN NEW MEXICO AND BERNALILLO COUNTY



	TOTAL PRODUCTION	
	NEW MEXICO	BERNALILLO COUNTY
TOMATOES	6,800	95
HOT PEPPERS	11,900	980
SWEET CORN	2,080	30
DRY ONIONS	72,600	1,125
LETTUCE & ROMAINE	85,800	420
WATERMELONS	3,800	0
MUSKMELONS & CANTALOUPS	1,800	60
CARROTS	1,900	0
APPLES	38,000	590
PEACHES	3,900	130
PEARS	1,400	20
MISCELLANEOUS FRUITS	840	90
TOMATOES (PROCESSING)	6,600	0
	230,820	3,540

Figure 13

DISTRIBUTION OF FOOD FATS AND OILS IN ALBUQUERQUE



a substantial share of the local produce market. The functions of these wholesalers are discussed in detail in Reference 88. Three firms distribute nearly 90 percent of the total volume of produce handled by Albuquerque wholesalers. Most of the shipments received by these firms come by truck from out-of-state growing areas. Distribution by the produce wholesalers is also by truck.

Processed Distribution

Fruit and vegetable processing plants are practically nonexistent in New Mexico. A few canneries located in the south and east parts of the state process tomatoes and specialty items. These canneries tend to be unstable, however, and their output is small.

On a fresh-equivalent weight basis, Albuquerque consumers purchase more processed fruits and vegetables annually than fresh produce. The lack of local processing facilities forces these consumers to rely almost exclusively on out-of-state producers for their annual supply. Canned and frozen fruits and vegetables enter the Albuquerque distribution system as general-line groceries at the wholesaler and retailer levels. Roughly two-thirds of the local supply is trucked in by chain retailers directly from their out-of-state warehouses. The remainder is handled by the general-line grocery wholesalers located in Albuquerque. Shipments to and from these local wholesalers are made by truck.

Food Fats and Oils

Production of U.S. fats and oils has doubled dramatically in the past hundred years, making this country a net exporter rather than a net importer. By 1965, U.S. production accounted for more than one-fourth of the world's total supply of fats and oils. Before World War II, the nation's share of the world market was around 5 percent (Reference 65).

In spite of production increases, the nation's total per capita consumption of edible fats and oils has remained relatively constant over the past three decades. The present breakdown of consumption is shown in Table 6.

Although the total per capita consumption of fats and oils has remained relatively constant in the past three decades, the relative contribution of animal and vegetable products to this total has changed substantially. Thirty years ago, animal products such as butter and lard made up 65 percent of the edible fats and oils consumed in the United

Table 6

PER CAPITA CONSUMPTION OF FOOD FATS AND OILS
1965

Food	Pounds per Capita
Table spreads	
Butter	6.5
Margarine	9.9
Subtotal	16.4
Cooking fats	
Lard	6.4
Shortening	13.9
Subtotal	20.3
Miscellaneous	
Mayonnaise and dressing	3.9
Other food products	10.3
Subtotal	14.2
Total product weight	50.9

Source: Reference 95.

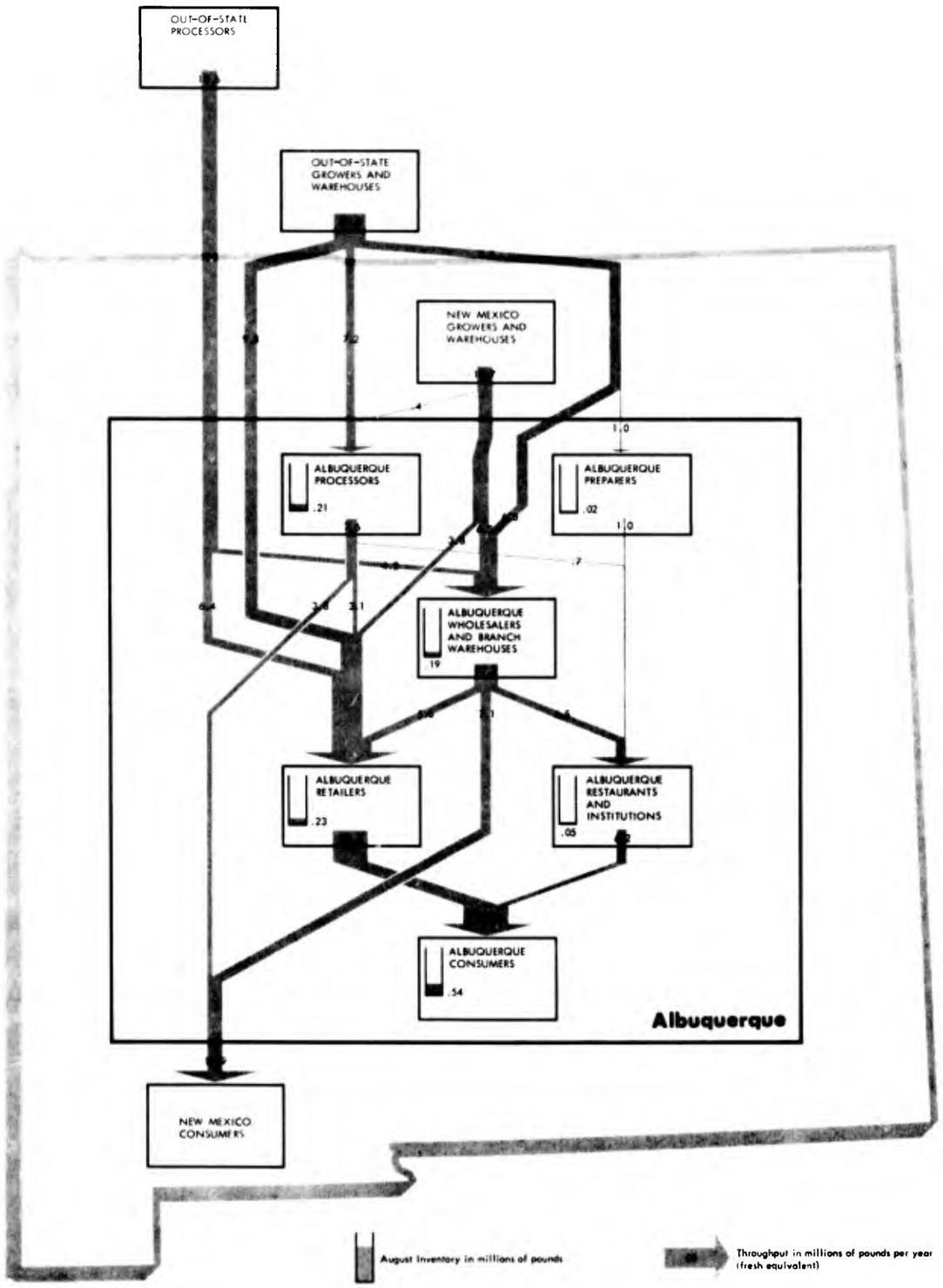
States. Today, vegetable oils lead by this margin. The two most important vegetable oils produced in the United States are soybean oil and cottonseed oil, with soybean oil accounting for two-thirds or more of the total production.

The Midwest is the center of soybean production and processing in the United States. Cottonseed oil is a by-product of the southern cotton industry. Bulk shipments of vegetable oil from processing centers in the midwestern and southern states are usually made in rail tankcars.

The distribution of food fats and oils in Bernalillo County is depicted in Figure 13. There is no significant processing of fats and oils

Figure 14

DISTRIBUTION OF POTATOES IN ALBUQUERQUE



within the county itself. Some New Mexico meat processors produce shortening as a by-product, and a few cottonseed oil mills are located in the cotton producing regions in the southeastern corner of the state. These companies ship their output directly to other processors. Commerical butter production is insignificant in the state, which imports its butter supply from Wisconsin and Colorado. Most of the butter, margarine, shortening, and other edible fats and oils consumed within Bernalillo County is supplied by large national firms and enters the county distribution system at the wholesale or retail level.

Potatoes

The flow of potatoes and potato products to Bernalillo County is illustrated in Figure 14.

Fresh Distribution

Roughly two-thirds of the potatoes used as food in Bernalillo County reach the consumer in fresh form. Of the fresh potatoes delivered to Albuquerque in 1965, approximately 38 percent were grown in New Mexico. The bulk of the remainder came from Colorado by truck and from California and Idaho by both rail and truck. Although there was no potato production in Bernalillo County in 1965, nearby Torrance County led the state in the production of this crop. Other potato-producing counties bordering on the Albuquerque SMSA are Santa Fe and Valencia Counties. In 1965, the three counties of Torrance, Santa Fe, and Valencia harvested 32.8 million pounds of potatoes, 93 percent of the total New Mexico harvest. Potatoes from these counties are harvested between August and November and trucked to the Albuquerque market, where they are delivered either to produce wholesalers or to retail outlets.

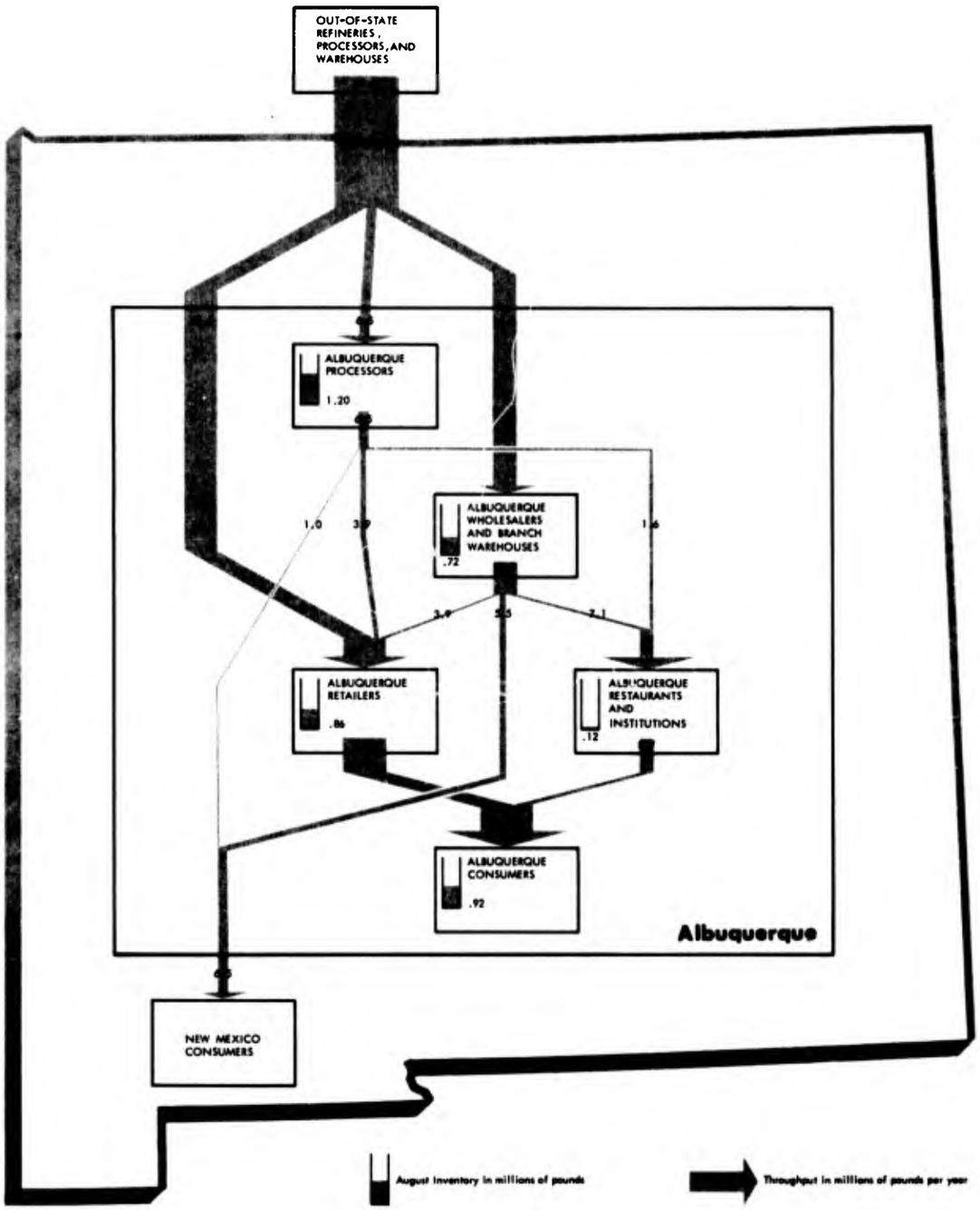
Potatoes imported from out of state for the fresh market follow the same marketing channels as other fresh produce. There is a growing tendency for out-of-state producers to deal directly with local retail outlets. Nonetheless, specialized produce wholesalers still command a respectable share of the local market for fresh potatoes.

Processed Distribution

The potato processing industry has enjoyed phenomenal growth in recent years. Reference 65 reports that the total quantity of potatoes shipped or utilized by food processors has increased more than 150 percent since 1956. This increase has been largely due to the growing

Figure 15

DISTRIBUTION OF SUGARS AND SWEETS IN ALBUQUERQUE



acceptance of frozen and dried potato products. The present composition of the processed potato pack, which constitutes one-third of the potatoes consumed in the United States, is as follows: 50 percent chips or shoestrings; 25 percent frozen french fries; 15 percent dehydrated potato flakes or granules; and 10 percent miscellaneous canned and frozen products.

The largest processors of potatoes in Bernalillo County are three potato chip factories that distribute their respective brands throughout New Mexico. The county also contains one company that "pre-pares" potatoes to order and delivers them in bulk to the local restaurant and institutional trade. Because of the nature of the product, potato chip production is strongly consumer oriented, and Albuquerque producers control a significant part of the local market. These producers tend to import their raw materials from out-of-state sources of supply. The raw materials inventory held by local chipmakers varies with the season because winter potatoes have to be conditioned for the chipping process. Albuquerque potato chip manufacturers distribute their own product by truck over fairly broad market areas.

Sugars and Sweets

Sugar is easily the most widely used sweetener in the United States. In recent years, however, a growing share of the sweetener market has been captured by corn syrup and noncaloric additives. In spite of this encroachment, sugar still retains more than 80 percent of the sweetener market.

Raw Sugar Production, Refining, and Distribution

The United States currently produces 56 percent of its sugar requirements domestically and imports the remainder. Sugar production for U.S. consumption, whether the sugar is of foreign or domestic origin, is governed by a quota system administered by the Secretary of Agriculture. This quota system empowers the Secretary to divide the U.S. consumption requirements among the various domestic and foreign producers on the basis of his estimate of future consumption needs.

Sugar beets require extensive processing in factories located relatively close to the area where the crop is grown. Sugar beet production is insignificant in New Mexico. Nearby Colorado, however, ranks third in the nation in the production of this beet. Sugar cane is usually processed first into raw sugar near the production areas, and later converted to refined sugar at separate refineries. U.S. sugar cane refineries tend to be located in port cities.

Sugar intended for consumption without further refining is distributed to users by four classes of producers or dealers. The proportion of the U.S. supply handled by each source in 1965 is identified in Table 7.

Table 7

REFINED SUGAR DISTRIBUTION
1965

	Thousands of Tons	Percent
Cane sugar refiners	6,335	67.3%
Beet sugar processors	2,828	30.1
Importers of direct-consumption sugar	176	1.9
Mainland cane sugar mill	65	.7
Total	9,404	100.0%

Source: Reference 65.

The distribution of sugar and sweets in Bernalillo County is depicted in Figure 15. Although New Mexico contains no sugar refineries, neighboring Colorado has more beet sugar refineries than any state in the country. While no statistics are available describing the exact distribution of the sugar that these refineries produce, it is logical to assume that they supply most of Bernalillo County's sugar.

Processed Sugar Products

For many years, the Census of Manufacturers (Reference 101) has shown soft drink bottlers to be one of the most numerous food processors in New Mexico. This population-oriented activity is centered in Bernalillo County, where each of the nation's six leading soft drink companies maintains a franchised operation. These local operations import their syrup concentrates from the out-of-state headquarters of the various franchising companies.

The operation of a soft drink bottling plant is extremely simple. In a detailed report on the industry (Reference 56) Shih and Shih note that the basic nature of the operation consists of cleaning bottles, adding water and sugar to a patented concentrate, bottling, packaging, and distributing the product to available outlets. The franchised bottlers of Bernalillo County supply nearly all of the local demand for soft drinks. Local deliveries are made by truck directly to food stores, drugstores, institutions, vending machines, restaurants and other retail outlets at regularly scheduled intervals.

There are four small processors of specialty candy located in Bernalillo County. In three of the four cases a retail operation accompanies the manufacturing activity. Their primary market is local, and raw materials are obtained locally when available.

In addition to the supplies of sugar held by soft drink bottlers and candy manufacturers, the distribution chart of Figure 15 reflects the sugar stocks inventoried by local bakeries. Because sugar tends to lose its basic identify in baked goods, however, the flow of processed sugar products depicted in Figure 15 is restricted to locally produced soft drinks and confectionery items. Thus, the 6.5 million pounds of sugar processed yearly in Bernalillo County represent the output of local soft drink bottlers and candy manufacturers and do not include the output of Albuquerque bakeries.

Miscellaneous Products

Several small processors of specialty food items and miscellaneous food products are located in Bernalillo County. Although these processors play a very small part in the normal county food distribution system, they could prove to be important in the postattack environment. A small feed mill, for instance, might be converted to emergency flour production. Because these processors are potentially important in postattack food distribution, they have been included among the local processors identified in Appendix C.

The list of miscellaneous processors in Appendix C includes a dog food manufacturer, a feed mill, and several processors of specialty items. The most numerous processors of specialty foods in Bernalillo County are those preparing Mexican food products. Most of these firms are small and cater to a limited market; they distribute directly to local retailers. Raw materials in Mexican food preparation include meal, chili peppers, and various forms of meat. For the most part these materials are obtained locally or from other New Mexico counties. Instances of out-of-state procurement are rare.

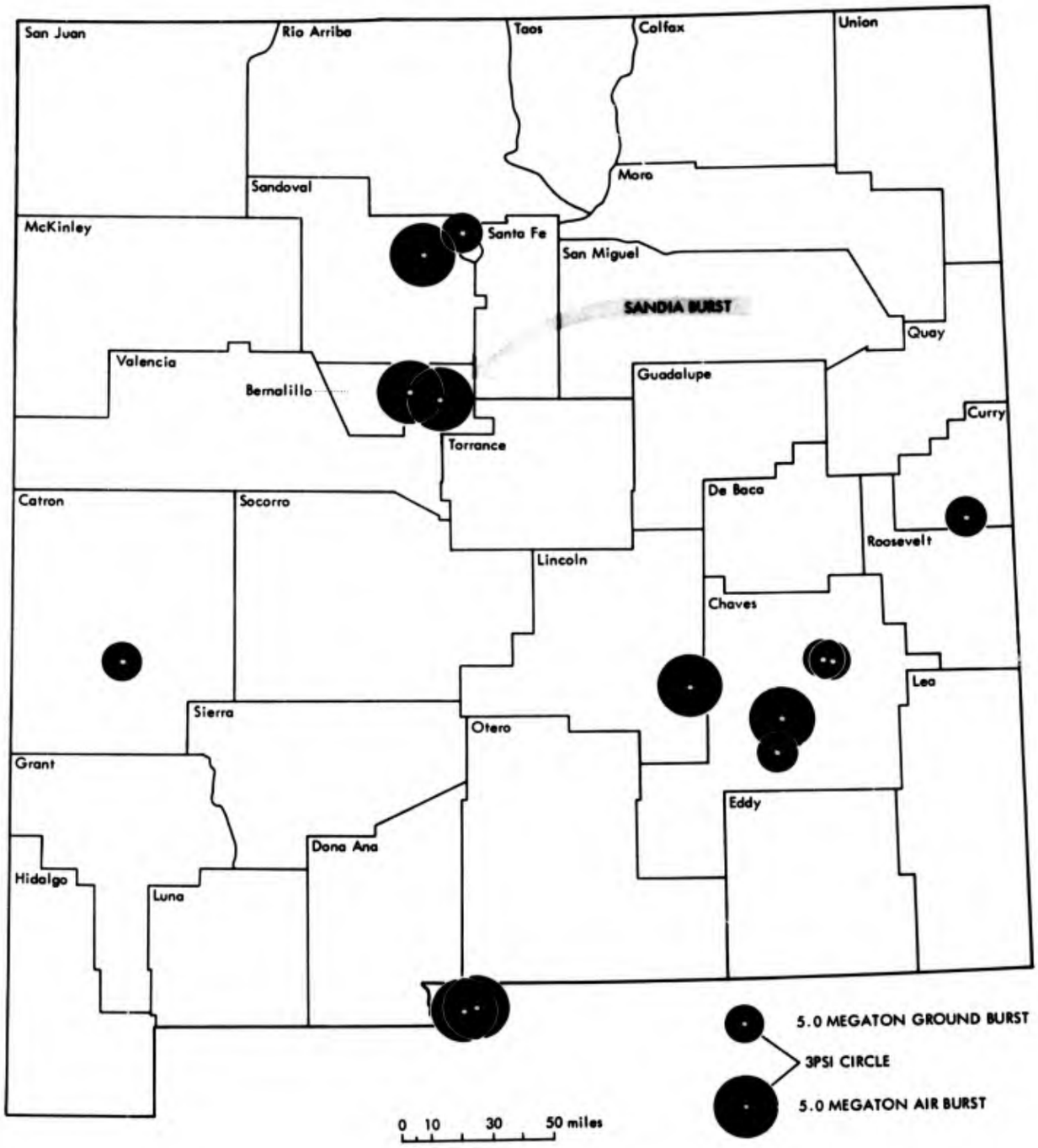
V METHOD OF ANALYSIS: POSTATTACK

To estimate the effects of a nuclear attack on the commodity distribution channels depicted in Chapter IV, it is necessary to formulate a damage assessment scheme capable of dealing with each channel element. Ideally, such a scheme would entail a point-by-point analysis of the effect of blast, fire, and fallout on each food processor, wholesaler, retailer, and consumer in the Albuquerque SMSA, as well as on such critical support subsystems as electricity, water, transportation, and the labor force. Point-by-point damage assessments were employed wherever possible in estimating the postattack condition of elements in the Bernalillo County food distribution system. Unfortunately, certain of the fire, population, and critical subsystem data required to support a point-by-point analysis were unavailable at the time the postattack analysis was made. In the case of retail food stores, restaurants, institutions, and individual homes, moreover, the very size of the data bases made damage assessment on a point-by-point basis impractical. In cases in which more general damage assessment schemes were formulated, an attempt was made to adapt the damage analysis to the form dictated by the data describing the food distribution system.

The attack scenario employed in the Five-City study (References 25 and 32) calls for 11 5-MT bursts to be delivered in the state of New Mexico and its immediate vicinity between 9:00 p.m. MST on August 24, 1965, and 12:05 p.m. MST on August 25. The location of these bursts is depicted in Figure 16. The first burst to arrive in the Albuquerque SMSA is detonated at 9:13 p.m. MST on August 24 at a height of 14,500 feet over the Sandia Military Reservation. In addition to the direct effects of this burst, the food distribution system of Albuquerque is further affected by fallout arriving from a ground burst detonated over Los Alamos, New Mexico at 1:42 a.m. MST on August 25. Thus, the chief concerns of a damage assessment scheme directed toward an evaluation of postattack food availability and accessibility in Albuquerque are the immediate effects of the Sandia burst, as reflected in population survival, fire spread, and blast damage, and the delayed effects of the Los Alamos burst, as reflected in radiation damage to the critical elements of the food supply system.

Figure 16

FIVE-CITY ATTACK PLAN, STATE OF NEW MEXICO



Population Survival

Movement to Shelter

The Albuquerque attack scenario (Reference 32) provides for the spontaneous evacuation of ten percent of the population prior to the August 24 attack. Because this evacuation was accomplished in a period of relative order, it was assumed that the evacuees were able to carry most of their home food supplies with them. For this reason, the food stocks to be found in the houses of Albuquerque consumers were reduced by ten percent before the initiation of the damage assessment program.

The Five-City attack plan allows the citizens of Albuquerque more than one and three-quarters hours between the sounding of the Civil Defense alert and the arrival of the Sandia burst. During this time, it is hypothesized that most of the populace will take cover in identified shelters. Although the National Fallout Shelter Survey listed an insufficient supply of shelters in Albuquerque, city planners propose to overcome this difficulty by using shelter spaces having relatively low protection factors and by carrying out an emergency construction program to provide approximately 100,000 additional spaces in improvised structures. By taking the location of existing and proposed shelter spaces into account, the Dikewood Corporation has prepared a listing detailing the locations of Albuquerque residents at the time of the Sandia burst. This location study, which is described in References 36 and 37, assumed that only about 15,000 people would fail to reach shelter by the time the attack occurred. Table 8 summarizes the assumptions of the Albuquerque attack scenario and the work of the Dikewood Corporation by listing the census tract locations of the Albuquerque population before and after the preattack evacuation, and at the time of the Sandia burst.

Population Fatality Estimates

Preliminary estimates of population fatalities in the Albuquerque SMSA have been prepared by the Dikewood Corporation using mortality curves published in Reference 15. These curves describe the vulnerability of persons in a given type of structure in terms of the structure's distance from ground zero. In preparing Albuquerque fatality estimates, the relocated population was assigned by standard location to 13 distinct types of structure. The results of the Dikewood study are summarized by census tract in Table 8. These results show that 260,298 of the Albuquerque SMSA residents may expect to survive the immediate effects of the Five-City attack under 1965 shelter conditions. This represents roughly 86.6 percent of the population remaining after the initial evacuation, or 77.4 percent of the pre-evacuation SMSA population.

Table 8

EVACUATIONS, SHELTER MOVEMENT, FATALITIES AND SURVIVORS BY CENSUS TRACT

Albuquerque

Census Tract	Resident Population	Evacuation	Net	Sheltered Population	Fatalities	Survivors
1-A	10,600	1,060	9,540	9,540	169	9,371
1-B	4,200	420	3,780	3,780	89	3,691
1-C	14,000	1,400	12,600	12,600	223	12,377
1-D	8,900	890	8,010	8,120	1,318	6,802
1-E	10,400	1,040	9,360	9,360	249	9,111
2-A	16,900	1,690	15,210	15,310	182	15,128
2-B	11,200	1,120	10,080	10,630	525	10,105
3	8,000	800	7,200	1,765	182	1,583
4	11,300	1,130	10,170	850	411	439
5	9,200	920	8,280	18,501	4,840	13,661
6-A	4,600	460	4,140	150	69	81
6-B	9,200	920	8,280	144	74	70
7	4,900	490	4,410	4,009	3,178	831
8	8,600	860	7,740	14,705	8,148	6,557
9	13,200	1,320	11,880	13,866	3,816	10,050
10	4,100	410	3,690	1,463	285	1,178
11	11,300	1,130	10,170	-	-	-
12	5,700	570	5,130	574	121	453
13	7,300	730	6,570	130	16	114
14	7,200	720	6,480	100	8	92
15	5,500	550	4,950	3,169	217	2,952
16	3,900	390	3,510	3,377	228	3,149
17	7,000	700	6,300	306	57	249
18	1,700	170	1,530	43,600	7,582	36,018
19	1,700	170	1,530	58	9	49
20	4,300	430	3,870	1,828	141	1,687
21	4,800	480	4,320	70,505	7,343	63,162
22	4,300	430	3,870	2,133	101	2,032
23	9,300	930	8,370	-	-	-
24	9,700	970	8,730	73	1	72
25	6,400	640	5,760	-	-	-
26	3,000	300	2,700	-	-	-
27	6,100	610	5,490	308	13	295
28	1,600	160	1,440	953	70	883
29	7,700	770	6,930	62	6	56
30	2,100	210	1,890	387	11	376
31	3,900	390	3,510	-	-	-
32	7,400	740	6,660	-	-	-
33	6,100	610	5,490	-	-	-
34	800	80	720	720	11	709
35	9,300	930	8,370	-	-	-
36	4,200	420	3,780	-	-	-
37	1,800	180	1,620	13,890	55	13,835
38	3,800	380	3,420	4,595	321	4,274
39	800	80	720	-	-	-
40	2,200	220	1,980	2,026	35	1,991
41	2,100	210	1,890	130	15	115
42	2,300	230	2,070	-	-	-
43	6,900	690	6,210	-	-	-
44	5,200	520	4,680	-	-	-
45	7,800	780	7,020	-	-	-
46	7,000	700	6,300	-	-	-
47	1,500	150	1,350	26,613	13	26,600
48	700	70	630	-	-	-
Total	333,700	33,370	300,330	300,330	40,132	260,198

The fatality estimates presented in Table 8 do not include casualties caused by fires ignited by the Sandia burst or fallout from the Los Alamos burst. Estimates of these additional fatalities were not available at the time the present report was prepared.

Labor Force Fatality Estimates

Separate assessments of the survival of management and labor personnel associated with Bernalillo County food distribution were made by combining the census tract data displayed in Table 5 with the population fatality estimates of Table 8. Before making these assessments, it was assumed, in accordance with the attack scenario, that 10 percent of the local management and labor personnel would join the evacuees leaving Albuquerque prior to the attack. In keeping with this assumption, nine of the 95 local residents at the management level in the food distribution system were selected by lot and identified as evacuees. In selecting 217 evacuees from the 2,171 Albuquerque food workers, it was assumed that 10 percent of the workers residing in each census tract would be a part of the preattack exodus.

The ratio of the number of fatalities to the total number of people seeking shelter in each Albuquerque census tract provides a good indication of the probability that a person seeking shelter in a particular tract will be killed by the effects of the Sandia burst. In order to apply this probability to the distribution of food management and labor personnel remaining in Albuquerque after the initial evacuation, it was first necessary to associate each of these personnel with a particular census tract at the time of attack. The location of management and labor personnel at the time of attack was obtained by applying the detailed shelter movement information contained in Reference 36 to the census tract distributions shown in Table 5 after accounting for preattack evacuations. The fatality probabilities associated with each census tract were then applied directly to the relocated labor force to give the expected number of deaths among Albuquerque food workers. This process resulted in the prediction that 219 local workers would be killed by the Sandia burst. When combined with evacuation losses, this figure leaves the Albuquerque food labor force at 80 percent of its preattack, pre-evacuation strength.

For purposes of postattack evaluation, the life or death of an individual having a specific management responsibility in the food distribution system cannot satisfactorily be determined by the assignment of a fatality probability. In practical terms, there is no such thing as a manager that is 75 percent dead. To make decisions regarding management

survival, a random number generator was used to predict the life or death of individual managers on the basis of the fatality probability associated with the census tract in which that manager sought shelter. This assessment system resulted in the prediction that 12 managers would be killed by the blast effects of the Sandia burst. Specific cases in which the loss of these managers, together with the absence of the nine evacuating managers, might affect postattack food processing or distribution are noted in Chapter VI.

Survivor Requirements

One measure of the postattack adequacy of a local food distribution system is the number of man-days of critical commodities that it is able to provide survivors in the postattack period. This measure implies certain assumptions regarding the nutritional requirements of survivors. The requirements used in this study were the National Emergency Food Consumption Standards specified by the U.S. Department of Agriculture in Reference 93. Table 9 summarizes these standards in terms of the commodity groups discussed in Chapter IV.

Table 9

NATIONAL EMERGENCY FOOD CONSUMPTION STANDARDS
(Food Allowance per Person per Week)

Commodity Groups and Food Items	Amount per Week
Meat and meat alternates (red meat, poultry, fish, shellfish, cheese, dry beans, peas, and nuts)	3 pounds
Eggs	6 eggs
Milk (fluid, whole)	7 pints
Cereals and cereal products (flour, including mixes, fresh bakery products, corn meal, rice, hominy, macaroni, and breakfast cereals)	4 pounds
Fruits and vegetables (fresh and frozen)	4 pounds
Food fats and oils (butter, margarine, lard, shortening, salad, and cooking oils)	1/2 pound
Potatoes (white and sweet)	2 pounds
Sugars, syrups, honey, and other sweets	1/2 pound

Source: Reference 93.

The standards of Table 9 were used in combination with Dikewood's preliminary casualty estimates to generate the total postattack demand facing the Bernalillo County food distribution system. This demand is summarized in Table 10. Because the results of Dikewood's preliminary analysis did not include deaths caused by fire and fallout, the weekly requirements of survivors listed in Table 10 may be expected to be somewhat conservative. The inclusion of fire and fallout fatalities would decrease the weekly requirements for each commodity group.

Table 10

POSTATTACK FOOD REQUIREMENTS

Bernalillo County

Commodity Group	Weekly Requirements
Meat and meat alternates	0.78 million pounds
Eggs	1.56 million eggs
Milk	1.82 million pints
Cereals and cereal products	1.04 million pounds
Fruits and vegetables	1.04 million pounds
Food fats and oils	.13 million pounds
Potatoes	.52 million pounds
Sugar and sweets	.13 million pounds

Fire Damage

Fire damage to food resources in Albuquerque was estimated using the data prepared by IITRI (Illinois Institute of Technology Research Institute) in developing and applying the fire-spread model described in Reference 63. In applying this model, the city of Albuquerque was represented by a grid of 373 square tracts measuring 1/2 mile on a side. Each tract was assigned to one of nine categories depending upon the size and composition of its built-up area. The length and width of potential firebreaks that separate adjacent tracts was also recorded. To determine the extent of fire damage in Albuquerque, the IITRI study estimated the percentage of buildings in each tract of the grid representation that would be ignited by the initial blast. The study then estimated the spread of fire by radiation and firebrands within and between tracts as a function of time. This calculation resulted in hour by hour estimates of the percentage of burned and burning buildings in each tract of the grid representation between 9:13 p.m. MST

on August 24, and 1:13 a.m. MST on August 26. By the latter time, the IITRI study predicted that fires in Albuquerque would have nearly burned themselves out, leaving only 17.3 percent of the city's buildings relatively free of damage.

To apply the results of the IITRI study to estimate the destruction by fire of food stocks held by Albuquerque retailers, restaurants, institutions, and consumers, a map overlay was prepared showing the correspondence between the 1/2 mile by 1/2 mile grid squares described in Reference 63 and the census tracts of Bernalillo County. The percentage of buildings destroyed by fire in each of the grid squares comprising a census tract was then weighted by an appropriate fraction of the built-up area in the tract. The weighted fire-survival percentages for each square contained in a tract were then added. The total provided an estimate of the percentage of survivals within the entire tract. Finally, these survival percentages were applied directly to the data bases that describe the tract-by-tract food holdings of Albuquerque retailers, restaurants, institutions, and consumers. This procedure resulted in the conclusion that only 10.6 percent of the stocks held by Bernalillo County retailers, 10.0 percent of the stocks held by restaurants and institutions, and 13.4 percent of the stocks held by consumers could be expected to escape destruction by fire under the Albuquerque attack conditions.

Because the IITRI study was designed to estimate the conflagration potential of entire Albuquerque tracts, the results are readily applicable to the estimation of the survival of tract-located food stocks. However, a certain amount of interpretation is required to apply these results to estimates of the survival of individual structures. For the purpose of estimating the conflagration potential of individual structures important in the Albuquerque food distribution system, each of the 89 processors and wholesalers listed in Appendixes A and B was assigned a fire destruction probability, P_f, based upon the results of the IITRI study. Each structure was assigned a probability that was based on the conflagration history associated with the 1/2 mile by 1/2 mile tract in which it was located. In the case of processors and wholesalers that were either isolated from or resistant to surrounding fire hazards, P_f, was taken to be the initial ignition probability assigned by Reference 63 to the tract in which the individual structure was located. All other processors and wholesalers were assigned values of P_f that corresponded to the percentage of buildings in the same grid tract that had been destroyed by the time that the IITRI study considered that the fire had run its course.

For damage assessment purposes, the question of the destruction of a particular building by fire cannot be satisfactorily answered by the assignment of a probability of destruction. Rather, this question requires a simple "yes" or "no" answer. To provide such an answer, a random number generator was used to predict the survival of each Albuquerque processor and wholesaler based upon the assigned P_f value. This random assessment system resulted in the prediction that 24 Bernalillo County food processors and 22 wholesalers would be destroyed by fire as a result of the 5-MT air burst over the Sandia Military Reservation. These processors and wholesalers are identified in Appendix C. Appendix C also contains a summary of the fire destruction probabilities associated with each processor and wholesaler in the Albuquerque SMSA. Stocks and equipment held by processors and wholesalers destroyed by fire were assumed to be totally lost.

A word of caution should be interjected regarding the above assessments of fire damage. Even though these assessments are in keeping with the current state of the art of fire prediction techniques, the general reliability of these techniques is not considered to be very high, especially when applied to individual structures. As such, the fire prediction undertaken in this report easily represents the weakest point of the postattack analysis. An attempt has been made, therefore, to so interpret the results of Reference 63 as to keep estimates of fire damage as conservative as possible. Hence, in this report, all estimates of fire damage to food stocks and production capability may be more accurately interpreted as upper bounds rather than as expected values.

Blast Damage

The state of the art of blast damage estimation is much more advanced than that of fire prediction. This fact is evident both in such recent work as the Advance Research, Inc., analysis of food industry repair problems (Reference 1) and in such standard references as The Effects of Nuclear Weapons (Reference 29).

Structural Damage

In the present study, a detailed analysis evaluated the structural damage to each Albuquerque food processor and wholesaler not assumed destroyed by fire. This analysis was greatly assisted by the work of the URS Corporation. As a part of the Five-City Study research, the URS Corporation supplied estimates of the structural damage suffered by 29 representative structures in the Albuquerque SMSA (Reference 23).

The work of the URS Corporation, together with the attack environment model contained in Reference 24 and The Effects of Nuclear Weapons handbook (Reference 29), provided a basis for an assessment of the blast damage suffered by the remaining processor and wholesaler structures listed in Appendixes A and B. No additional blast damage analysis was undertaken for structures assumed destroyed by fire. The results of the structural damage assessment are summarized in Appendix C.

Equipment Damage

Once the structural damage to Bernalillo County food facilities had been analyzed, the work (Reference 1) of Advance Research, Inc., was used as a guide in estimating the damage to the processing equipment housed within these facilities. This work contains a detailed analysis of the vulnerability of a wide variety of food processing equipments as a function of incident overpressure and structural damage. In performing this analysis, Advance Research, Inc., also attempted to estimate the repair time associated with varying degrees of equipment damage. These estimates of repair time were used in the present study to determine the equipment downtime that each Bernalillo County processor suffered as a result of the Sandia burst. In determining downtime, each processing plant was assumed to have 80 percent of its preattack labor force available for performing repair work and resuming operations following an attack. This estimate was in accordance with the results of the labor force survival exercise described earlier in this chapter.

The amount of repair time needed for food processing structures and equipment was balanced against the seasonal nature of a particular plant's output to determine the plant's production capability in the first postattack year. Thus, a cannery that normally operated only in September and October would have no production capability in the first postattack year if it suffered a 60-day downtime as a result of the August 24 attack. A cannery whose normal operating months were June and July, however, would have no loss in production capability brought on by a 60-day repair interval. As used in this report, production capability is independent of the availability of raw product supply. Thus, an undamaged processing plant with all its workers surviving would be considered to have 100 percent production capability during the first postattack year even if the attack were to destroy its entire raw product supply. A summary of the equipment damage, repair times, and first-year production capability of each Albuquerque food processor not destroyed by fire is presented in Appendix C.

Inventory Damage

Little quantitative research has been published detailing the effects of blast on stored foodstuffs. Reference 29 contains a qualitative description of the results of exposing some 90 perishable and nonperishable food products to nuclear explosions in the 1955 Nevada tests. These sample food products were placed in test buildings at distances ranging from about a quarter of a mile to about 15 miles from ground zero. In describing the condition of the sample foodstuffs following the test blast, Reference 29 reports that:

> Fresh food products, such as potatoes, apples , and onions, packaged in the usual light wooden boxes, suffered from bruising and crushing. Apart from this, there was relatively little direct blast damage. There were very few (if any) failures of glass or metal containers due to the high overpressures, although some were pierced by sharp missiles, especially flying glass. The damage to packaged goods resulted mainly from dislodgement from the shelves in the kitchen and subsequent breakage of glass containers. Where the cans or jars had been stored on shelves in the basement, the damage was negligible, even when the main structure of the house was demolished.
>
> Containers made of soft materials, such as paper, polyethylene (plastic) or cardboard, were badly damaged by flying debris. In these cases the food products were often seriously contaminated with splintered glass. Where there was adequate protection, however, the direct and indirect consequences of blast were not serious.

The above information was used as a guide to estimate the extent of blast damage to food stocks held by the Bernalillo County processors and wholesalers listed in Appendixes A and B. The chief elements of concern in the damage estimation procedure were the perishability of the stored food, the type of containers used, and the extent of debris predicted in the structural damage assessment. Food stocks stored in facilities destroyed by fire were assumed to be completely lost.

Another concern in estimating the survival of stored food was the postattack availability of electricity for refrigeration. Preliminary estimates by the Five-City research contractor, which is engaged in assessing damage to the power supply networks of both San Jose and Albuquerque, indicate that a total power failure can be expected within the five psi and higher

blast pressure range surrounding ground zero. These same estimates indicate that little damage to the electrical system can be expected in regions experiencing less than two psi blast overpressure. Little information is available, however, concerning the availability of electrical power in the critical range between two psi and five psi. In keeping with the conservative approach to damage assessment employed in estimating fire damage, therefore, a high percentage of spoilage was assumed in the case of those perishable foods requiring refrigeration located in this critical blast range. A summary of the perishable and nonperishable inventory estimated as lost by each Bernalillo processor and wholesaler appears in Appendix C.

In addition to processors and wholesalers, such food distribution links as retail stores, restaurants, institutions, and consumers are also subject to inventory losses caused by blast. To provide a basis for evaluating these losses by census tracts, the point-by-point assessments of processor and wholesaler inventory in Appendix C were grouped according to the distance of each storage point from ground zero. This sample was augmented by similar assessments compiled in the course of the San Jose case study described in Reference 7. The similarity of attack conditions dictated by the Five-City Study for both Albuquerque and San Jose made it possible to combine separate data sources in this fashion.

Once the sample storage points had been grouped by their distance from ground zero, the average damage to perishable and nonperishable food stocks was computed as a function of this distance. The resulting damage function is summarized in Table 11. This function is in good agreement with the more general guidelines regarding the loss of perishable foodstuffs established by the Five-City Study research contractor responsible for evaluating Albuquerque's postattack waste disposal problems (Reference 33).

The weighted-average function in Table 11 represents a combined damage function for both perishable and nonperishable goods. This average is based on statistics showing that 70 percent of the shelf space devoted to food in retail stores is used for displaying nonperishable goods (Reference 52). Assumption of a total power failure and consequent spoilage of almost all perishable goods within the two psi blast radius makes the damage function displayed in Table 11 somewhat conservative.

By applying the appropriate damage function of Table 11 to tract-distributed stocks not assumed destroyed by fire, it was conservatively estimated that only 1.2 percent of the perishable stocks held by local retailers, 2.0 percent of the perishable stocks held by consumers, and 1.4 percent of the perishable stocks held by restaurants and institutions could be expected to survive both the fire and blast effects of the Sandia

burst. In the case of nonperishable foodstuffs, 4.3 percent of the retail holdings, 6.1 percent of the household stocks, and 5.6 percent of the restaurant and institution-held supplies could be expected to survive both blast and fire.

Table 11

PERCENTAGE OF BLAST-CAUSED INVENTORY LOSSES*

Range (1,000 Meters)	Perishable	Nonperishable	Weighted Average
0 - 2.99	100	100	100
3 - 5.99	100	100	100
6 - 8.99	100	85	90
9 - 4.99	100	77	84
12 - 14.99	98	59	71
15 - 17.99	78	50	58
18 - 20.99	57	27	36
21 - 23.99	45	18	26
24 - 26.99	36	12	19
27 - 29.99	25	0	8
30 - 44.99	15	0	5
45	0	0	0

* For Albuquerque attack conditions, Five-City Study.

Summary of Damage Categories

The combined effects of fire and blast on the structures, equipment, and inventories of Bernalillo County processors and wholesalers have been summarized in Table 12. The damage code displayed in this table corresponds to that used in Appendix C.

Table 12

DAMAGE DISTRIBUTION SUMMARY
Bernalillo County

Damage Code	Damage Category	Processors	Wholesalers	Total
N	Negligible blast damage	0	0	0
N - L	Negligible to light blast damage	1	0	1
L	Light blast damage	3	1	4
L - M	Light to moderate blast damage	2	3	5
M	Moderate blast damage	8	4	12
M - H	Moderate to heavy blast damage	5	4	9
H	Heavy blast damage	3	7	10
F	Destroyed by fire	24	22	46
OB	Unclassified--out of business	2	0	2
		48	41	89

Radiation Damage

Fallout from the Los Alamos burst can be expected to arrive in northern Albuquerque at about 8:00 a.m. on August 25. The attack environment model (Reference 24) estimates that radiation intensity in the city will reach its peak at about 12:00 noon on this same day. Peak intensities

at this time will vary from 24 roentgens per hour in northernmost Albuquerque to 12 roentgens per hour at the southern city limits. Fallout deposition in the southernmost sector of the city will cease around 1:00 p.m. on August 25. By September 1, radiation intensity will have dropped below one roentgen per hour in all sections of Albuquerque.

As long as the citizens of Albuquerque make intelligent use of the shelters identified in the attack scenario during the first week following the attack, the fallout deposited by the Los Alamos burst is not likely to have a serious effect upon the surviving population. Emergency food supplies stored in the shelter spaces will also remain free from radiation damage. Nor is the fallout likely to deplete significantly those food stocks in the distribution system which manage to escape destruction by blast and fire. In the absence of refrigeration, it has been seen that most of the surviving supplies will be nonperishable foodstuffs, such as canned goods, candy, and packaged cereal products. Even if the outside of the containers of such foodstuffs were contaminated by fallout, most of the radioactive substance could be removed by washing the container before opening it. The container's contents may then be removed and consumed without significant contamination to the consumer. Thus, the chief effect of fallout on postattack food availability and accessibility in Albuquerque may be expected to be contamination of the exposed crops and livestock in and around the city.

Crop Contamination

The susceptibility of various food and feed crops to radioactive contamination has been investigated and reported in References 45 and 12. The following two criteria for crop survival in a radioactive environment are employed in Reference 12: " . . . first, the crops must survive the damaging effects of fallout gamma and beta radiation, which can either kill plants outright or sharply reduce their yield of edible product; and second, even if the crops could survive radiation effects, the farmer must be able to plant and harvest the crop and tend to it during the working period." In applying the first of these criteria to the produce of Bernalillo County, it is found that, of local crops, the tomato is the most sensitive to gamma radiation. The seven-day dose required to kill the tomato plant is 3,000 roentgens (Reference 45). By comparison, the lethal dose for apples and dry onions, the most plentiful local fruit and vegetable is 5,000 roentgens. The attack environment model shows that the maximum seven-day dose in Bernalillo County is not expected to exceed 1,500 roentgens. Even ignoring the effects of terrain attenuation, this amount is well below the gamma radiation sensitivity of the most susceptible local crop.

The August 24 attack interrupts the cultivation of dry onions, the largest local crop, at the midpoint of the harvest season. As harvesting can be resumed within one week following the attack, this interruption should not cause a significant decrease in the crop size. The other sizable county crops--tomatoes, apples, and hot peppers--all approach maturity at the time of the proposed attack. The harvest season for each of these crops begins in early September. By that time, radiation levels will have subsided sufficiently to permit harvesting. In view of the relatively low dose levels received by local crops, therefore, and the short period of time during which farmers would be denied access to these crops, it can be assumed that fallout from the Los Alamos burst will have a negligible effect upon the Bernalillo County harvest.

Livestock Contamination

The model for livestock survival used in the present study is identical to that developed and demonstrated in References 45 and 12. The survival criterion employed in these references considered gamma radiation to be the chief hazard to livestock following nuclear attack. The radiation dosage expected to kill 50 percent of various species of livestock within 30 days of initial exposure is displayed in Table 13.

Table 13

LIVESTOCK LETHAL DOSES

Animal Species	Expected Lethal Dose (Roentgens)
Chickens	900
Hogs and pigs	510
Milk cows	540
Steers, bulls, and calves	540
Sheep and lambs	520

Source: Reference 12.

In applying the information given in Table 13, it was assumed that for every animal that managed to survive a dosage in excess of the expected lethal dose, another animal that received less than the lethal dose would die. Thus, the total number of livestock fatalities could be estimated by counting the number of animals receiving a dose equal to or greater than the expected lethal dose.

Those sections of Albuquerque in which the radiation dosage predicted by the attack environment model (Reference 24) exceeds the expected lethal dosage for local livestock are shown in Figure 17. In constructing Figure 17, a terrain attenuation factor of 25 percent was imposed upon the dosage levels predicted in Reference 24. Aside from the natural shielding afforded by terrain contours, however, the animals were considered to have no fallout protection. This assumption is somewhat conservative; the existence of barns and the herd instincts of the animals can be expected to afford a certain amount of protection against radioactivity. The areas of lethal dosage indicated in Figure 17 enclose 23 percent of Albuquerque's cattle and calves, 32 percent of her milk cows, 36 percent of her hogs and pigs, and 36 percent of her sheep and lambs. Local poultry would not be affected by the dosage levels predicted in the attack environment model.

Animals that become sick under the influence of radiation, but that do not die, are considered to recover sufficiently to be utilized later as meat. The possibility of slaughtering animals thought to have received lethal doses soon after the attack for the purpose of supplementing the postattack meat supply is discussed in Chapter VI.

Although neither Reference 45 nor Reference 12 deals directly with the problem of contaminated pasture land, Reference 12 notes in passing that pasture grass is not particularly radiosensitive and that most varieties of it have an excellent regenerative capacity. Hence, it is assumed that there will be an ample supply of pasture grass for the surviving animal herds. No attempt has been made in the present study to evaluate the number of livestock deaths that might be caused by ingestion of fallout-contaminated pasture grass. Just as radiation-sick livestock may be slaughtered immediately and used for meat, however, so may livestock made ill by ingested fallout material be used to supplement the postattack meat supply.

State and National Damage Assessments

Assessment techniques similar to those employed in Bernalillo County were used to estimate damage suffered by other New Mexico counties as a result of the Five-City Study attack. Those counties damaged directly by the

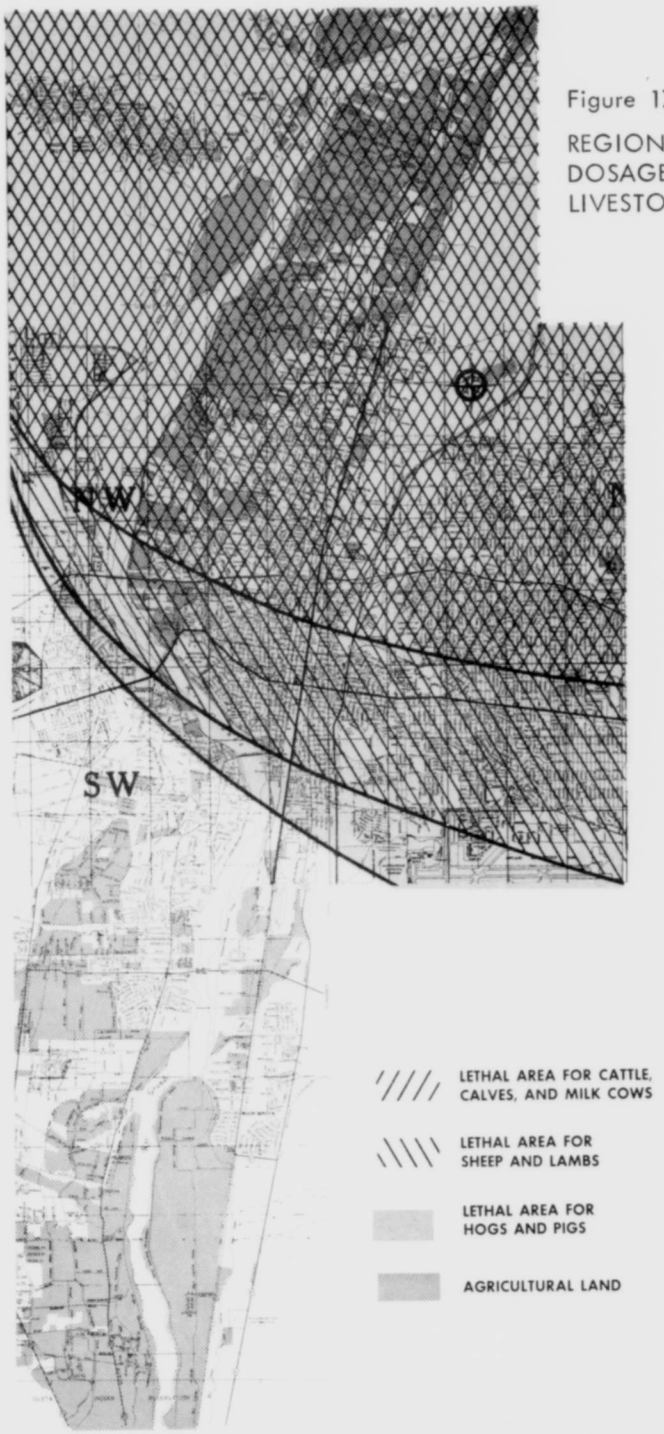


Figure 17

REGIONS OF RADIATION DOSAGE LETHAL TO LIVESTOCK

attack have been identified in Figure 16. A detailed damage analysis was undertaken only in those counties whose resources have a significant effect on Albuquerque food distribution. Typical of the county resources investigated were the potato crop of Torrance County, the egg production of Dõna Ana County, and the meat packing facilities of Chaves County. Data regarding county agricultural production were obtained from References 99 and 50, and information regarding county processors was obtained from Reference 19.

Detailed damage assessments based on the Five-City attack were also made in the case of a few selected processors and wholesalers located in neighboring states. Such assessments were made only for food facilities known to exert a direct influence upon Albuquerque food distribution. These facilities included Colorado flour mills and sugar beet refineries and chain store warehouses located in Texas. The sizes and locations of these facilities were ascertained through the use of References 106, 21, and 17.

Except for the Colorado and Texas assessments noted above existing nationwide damage assessments were used to determine the postattack degradation of out-of-state inputs to the Albuquerque food distribution system. In the case of national crop and livestock resources, the assessments used were those described in Reference 12. This reference reports the results of a 1968 Stanford Research Institute study that used the Institute's DASTAD (Damage Assessment Tape) program to estimate the effects of two different nuclear attacks on the crop and livestock resources of each county in the United States.

The total yield delivered in the lighter of the two attacks considered in Reference 12 was approximately 1,300 MT. This yield was almost doubled in the heavier attack. Thus, the two attacks bracketed the total projected force of the attack used in the Five City Study, which was roughly 1,900 MT. It follows that the national estimates of crop and livestock damage associated with the lighter and heavier attacks reported in Reference 12 may appropriately be considered as lower and upper bounds on the damage to be expected from the Five-City attack. In keeping with the conservative approach used in assessing local damage throughout this report, upper bounds were used in all postattack analytic work requiring quantitative estimates of national damage.

Although the Five-City Study scenario calls for an attack on August 24, the hypothetical attacks described in Reference 12 took place in mid-June. The 2-1/2 month difference between the postulated attacks could have a significant effect on the survival of the nation's crop and livestock resources. Most national crops are planted in June and

are more vulnerable immediately after planting than in August, which is later in their life cycle. Thus, the season of attack provides another reason for considering the estimates of damage resulting from the heavier attack of Reference 12 as an upper bound on the probable range of Five-City attack damage.

The investigation of postattack food resources described in Reference 12 was not concerned with the survival of the nation's food processing industry. In a study conducted in 1963, however, estimates of the effects of four separate attacks on U.S. food processors were made for SRI by the National Resource Evaluation Center. These estimates are recorded in Annex C of Reference 61. A later SRI study, which is described in Reference 8, updated these estimates for processors handling milk and wheat products. The estimates recorded in References 61 and 8 were used when the postattack analysis of Bernalillo County food distribution required an assessment of national processor damage. Because the attacks used in developing these estimates were all much heavier than the postulated Five-City attack, however, the estimates of processor damage in References 61 and 8 also represent an upper bound on Five-City attack damage.

Estimates of damage to the transportation system of the United States were also drawn primarily from existing work. References 58 and 62 describe existing SRI research relevant to the national postattack transportation situation. The question of national transportation was investigated in connection with the Albuquerque study only when it was apparent that, to meet postattack food requirements, critical commodities might have to be brought into Albuquerque from long distances.

VI POSTATTACK FOOD INVENTORIES AND DISTRIBUTION

Commodity Inventories

The immediate postattack availability of food to survivors in the Albuquerque SMSA is summarized in Table 14. This table itemizes the inventories of each critical commodity held by Bernalillo County processors, wholesalers, restaurants, retailers, and consumers, both before and after the August 24 attack. Commodity holdings are expressed both in common sales units and in terms of the times required to deplete preattack and postattack inventories. Depletion times were calculated by assuming the population would subsist on the weekly rations identified in the National Emergency Consumption Standards (Table 9).

Table 14 identifies fluid milk and eggs as the commodities likely to be in shortest supply following a nuclear attack on Bernalillo County. In view of the daily production requirements and the perishability of milk and eggs, this result is hardly surprising. Shortages of meat, potatoes, and cereal products may also be expected in the immediate postattack period. The depletion times for the remaining foodstuffs listed in Table 14 exceed one week, with the sugar and syrup reserves of Albuquerque bakers and soft-drink bottlers making sugars and sweets the longest lasting commodity group.

The depletion times represented in Table 14 provide a partial indication of the length of time Bernalillo County might exist as an "island of survival" if isolated from the nation at large. These times do not, however, represent a complete measure of the county's survival potential. The depletion times of Table 14 do not include fallout shelter stocks supplied by the federal government. According to the Albuquerque attack scenario, each of the 312,500 shelter spaces available in the city would be fully supplied with standard issue food stocks at the time of attack. These stocks, consisting of cartons of such hardy foodstuffs as rock candy and crackers, could be made to last fourteen days under careful postattack management. Since practically all of the 260,298 survivors of the Sandia burst are shelter occupants, it can be assumed that each survivor will have access to a fourteen-day food supply. The surviving perishables listed in Table 14 would undoubtedly be used to supplement this supply during the first two weeks following the attack.

After depletion of the federally supplied emergency shelter stocks, the ability of the county to function in the postattack recovery period

Table 14

PREATTACK AND POSTATTACK COMMODITY INVENTORIES
(Bernalillo County)

	Processors	Wholesalers and Cold Storage Warehouses	Restaurants and Institutions	Retailers	Consumers	Total Inventory
Meat and meat alternates						
Preattack						
Millions of pounds	1.73	0.64	0.06	0.77	0.52	3.72
Weeks	1.73	0.64	0.06	0.77	0.52	3.72
Postattack						
Millions of pounds	0.04	0.28	--	0.02	0.02	0.36
Weeks	0.05	0.36	†	0.03	0.03	0.47
Milk						
Preattack						
Thousands of gallons	38.6	5.4	5.2	16.5	40.3	106.0
Weeks	0.13	0.02	0.02	0.06	0.14	0.34
Postattack						
Thousands of gallons	--	--	0.07	0.20	0.80	1.07
Weeks	†	†	†	†	†	†
Eggs						
Preattack						
Thousands of dozens	13.3*	71.0	3.4	50.0	62.5	200.2
Weeks	0.08*	0.43	0.02	0.30	0.38	1.21
Postattack						
Thousands of dozens	--	2.8	0.05	0.60	1.25	4.70
Weeks	--	0.02	†	†	0.01	0.03
Cereals and cereal products						
Preattack						
Millions of pounds	0.88	1.05	0.07	1.19	1.55	4.74
Weeks	0.66	0.79	0.05	0.89	1.16	3.55
Postattack						
Millions of pounds	0.34	0.35	--	0.05	0.09	0.83
Weeks	0.33	0.34	†	0.05	0.09	0.81
Fruits and vegetables						
Preattack						
Millions of pounds	--	3.34	0.32	2.53	2.36	8.55
Weeks	--	2.50	0.24	1.90	1.77	6.41
Postattack						
Millions of pounds	--	0.87	0.01	0.10	0.12	1.10
Weeks	--	0.84	0.01	0.10	0.11	1.06
Fats and oils						
Preattack						
Millions of pounds	0.07	0.42	0.06	0.50	0.50	1.55
Weeks	0.42	2.52	0.36	3.00	3.00	9.30
Postattack						
Millions of pounds	0.02	0.26	--	0.02	0.03	0.33
Weeks	0.15	2.00	†	0.15	0.23	2.53
Potatoes						
Preattack						
Millions of pounds	0.23	0.26	0.05	0.23	0.54	1.31
Weeks	0.34	0.39	0.08	0.34	0.81	1.96
Postattack						
Millions of pounds	0.07	0.05	--	0.01	0.03	0.16
Weeks	0.13	0.10	†	0.02	0.06	0.31
Sugars and sweets						
Preattack						
Millions of pounds	1.20	0.72	0.12	0.86	0.92	3.82
Weeks	7.20	4.33	0.72	5.16	5.54	22.95
Postattack						
Millions of pounds	0.26	0.23	0.01	0.04	0.06	0.60
Weeks	2.00	1.77	0.08	0.31	0.46	4.62

* Inventories held by producers and product distributors.
† Less than .01 week.

will depend on her own agricultural resources and on the survival of the distribution pipelines of the various commodities. The postattack condition of this pipeline and the resources supplying it is examined in the following section.

Commodity Distribution

In considering postattack commodity distribution, the chief concern of this study is the ability of the preattack supply pipeline described in Chapter IV to function successfully in the postattack environment. This concern is in keeping with the stated intent of federal, state, and local authorities to avoid postattack interference with normal food distribution channels except as necessary to assure survival and the conduct of emergency operations (Reference 83). Accordingly, alternative distribution measures are discussed only when it is apparent that the preattack distribution system is completely incapable of supporting postattack commodity flow.

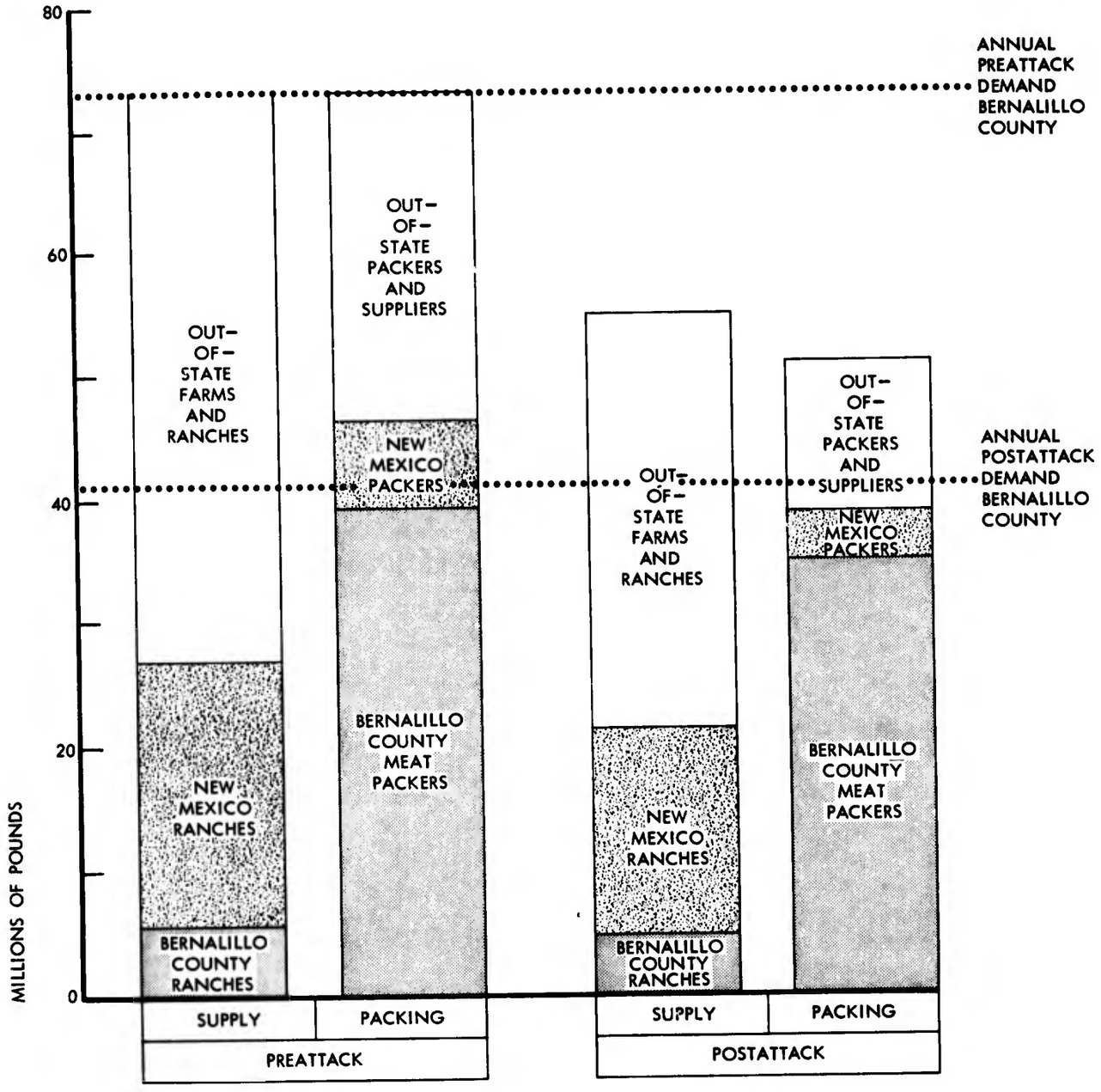
Meat and Meat Alternates

The relative survival of the meat and poultry supply and the meat packing plants serving Bernalillo County is depicted in Figure 18. In constructing this figure, the relative contributions of livestock and poultry farmers and packers located in Bernalillo County, in the state of New Mexico, and in the remaining states of the Union were obtained from the meat distribution chart, Figure 6. The results of local, state, and national damage assessments were applied to the contributions shown in Figure 6 to obtain the postattack estimates displayed in Figure 18.

Figure 18 shows that more than enough meat and poultry from Bernalillo County's preattack sources may be expected to be available to satisfy postattack demands. Slightly more than half of the county's postattack demands can be met by suppliers located either in New Mexico or in the county itself. Furthermore, the survival of the plant and management of the county's largest meat packer guarantees that the local meat packing capability will be sufficient to handle this supply. It is estimated that the August 24 attack will destroy only eleven percent of the county's meat packing capability. An additional four percent of this capability may be rendered ineffective by the loss of management. Nonetheless, the surviving local and national packing capability should be more than adquate to meet the demands of Albuquerque survivors in the first postattack year.

Figure 18

SURVIVAL OF SUPPLIERS AND PACKERS OF MEAT AND MEAT ALTERNATES SERVING BERNALILLO COUNTY CONSUMERS



Although many individual Albuquerque meat wholesalers may expect to suffer heavy damage from the Sandia burst, the most prominent local wholesaler, a representative of one of the country's largest meat packing firms, should be only slightly damaged. The survival of the warehouse and management of this firm, along with the survival of a few smaller establishments, leaves Albuquerque's meat wholesalers at 70 percent of the overall preattack capability. Since Albuquerque meat wholesalers play an insignficant part in the distribution of locally produced meat products, moreover, this figure could be much lower without seriously affecting the ability of the meat distribution system to function in the postattack environment.

Although Figure 18 shows the outlook for Albuquerque meat distribution over the first postattack year to be promising, shortages can be expected in the period immediately following the attack. Table 14 reveals that the supply of preapred meat surviving the Sandia burst will last little longer than three days. Although the meat substitutes in the fallout shelter stocks will sustain most of the Albuquerque survivors during the first two postattack weeks, some other source of meat products will have to be found during this period if survivors in Bernalillo County are to maintain the minimum consumption standards listed in Table 9.

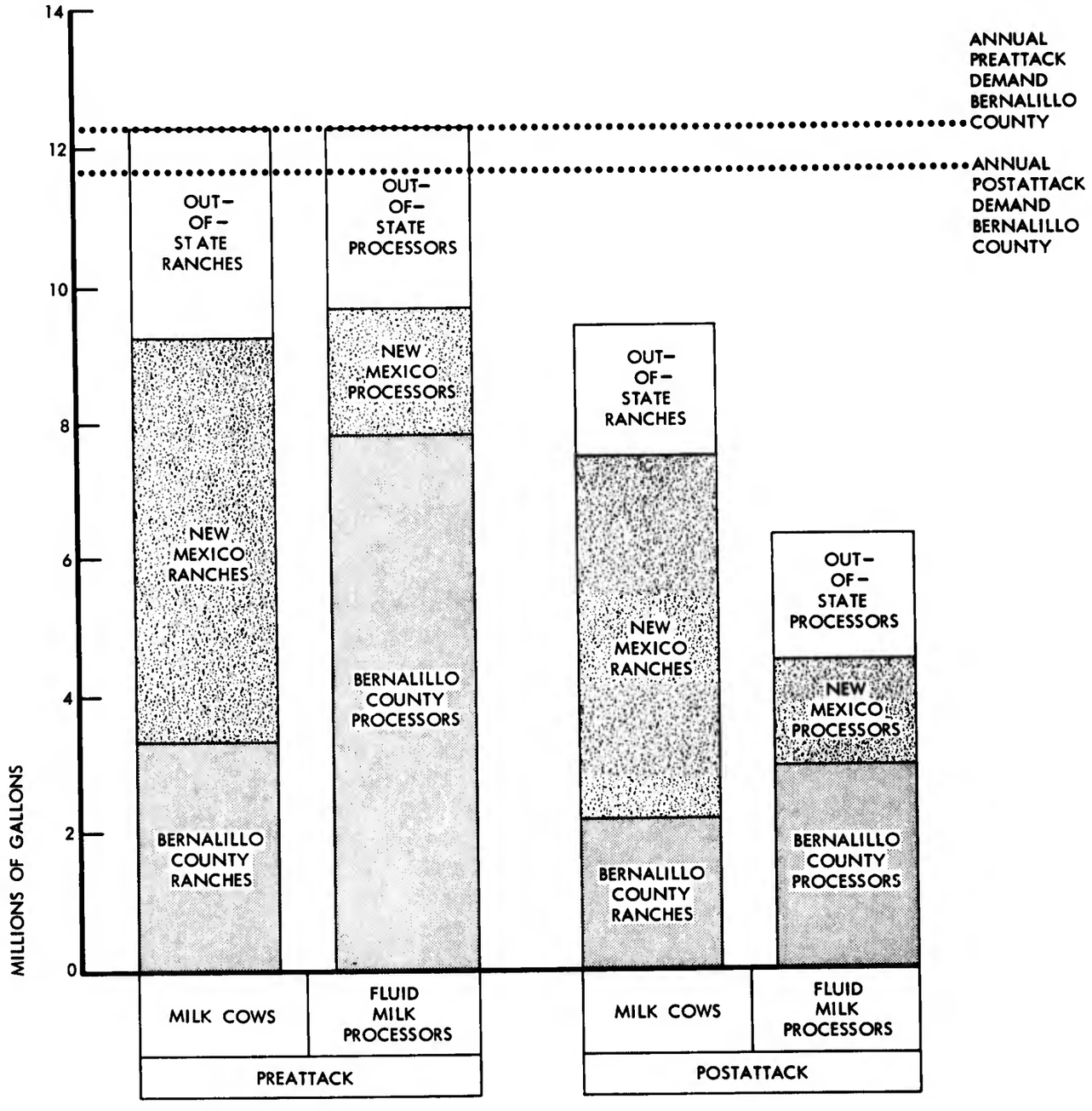
In order to minimize the immediate postattack shortage of meat and meat alternates, local slaughterhouse activity should resume as soon after the attack as possible--when electricity for refrigeration becomes available and when the radiation level is low enough to permit activity. In the case of certain packers, the shutdown period could be as short as one week. Insofar as possible, Albuquerque meat packers should endeavor to perform business as usual while at the same time repairing their facilities. The rapid resumption of slaughtering activities should make it possible to reclaim some portion of those meat animals that have received lethal radiation doses. If slaughtered soon enough after the attack, such animals may still be used for food. As the livestock receiving radiation doses strong enough to prove lethal represent more than a three-week supply of meat to Albuquerque survivors, their timely slaughter would help to alleviate meat shortage problems in the immediate postattack period.

Milk

The relative survival of the dairy farms and fluid milk processors serving Bernalillo County consumers is depicted in Figure 19. This figure shows that the availability of both dairy cattle and fluid milk

Figure 19

SURVIVAL OF MILK COWS AND FLIUD MILK PROCESSORS SERVING BERNALILLO COUNTY CONSUMERS



processors during the first postattack year will be insufficient to meet the relatively high requirements of the survivors. Only 38 percent of Bernalillo County's fluid milk processing capability is expected to survive the postulated attack. Even though processors in New Mexico and the surrounding states suffer lighter damage, dairy farmers serving Albuquerque will be left with little better than half of the processing capability required to meet the demands of the first postattack year. In the long run, managers of the surviving milk processing plants might take advantage of the economies of scale available in the industry to enlarge their operations and close this processing gap. In the short run, however, the extensive damage suffered by the large local processors will accentuate fluid milk supply problems. The largest local processor to escape destruction by fire is expected to require four to five months of repair activity before achieving preattack production levels.

Fluid milk availability in the immediate postattack period will also be hampered by the presence of fallout. One USDA pamphlet (Reference 76) warns that the existence of contaminated feed on dairy ranches could cause survivors in fallout areas to be without fresh milk for periods up to two months following an attack. An initial drop in milk production could also be caused by the absence of electricity for operating milking machines or by the inability of ranchers safely to milk cows in Albuquerque's fallout environment. Milkings missed immediately following the attack could have serious repercussions later, as unmilked cows tend to develop mastitis. The widespread incidence of this mammary inflammation would further limit the availability of good milk. Even if local dairy farmers are able to attend to their surviving cows after the Sandia burst, however, Albuquerque survivors may expect acute shortages of fluid milk in the months immediately following the attack.

A partial solution to the milk supply problems caused by fallout may be achieved by channeling milk produced immediately following the attack into the production of manufactured dairy products. This practice would extend the storage life of the milk, allow its radioactive content to decay, and minimize the need for postattack refrigeration. Unfortunately, the only large Albuquerque dairy equipped to produce manufactured milk products is not expected to survive the blast-caused fires. Hence, the channeling of postattack milk into such products as cheese and butter would have to be undertaken by small processors or by the dairy farmers themselves. While such activity is useful and desirable, it is doubtful that the small processors and farmers of Albuquerque have sufficient facilities to convert a significant portion of postattack milk into manufactured dairy products, under all the conditions of the hypothetical attack used in the Five-City Study.

Table 15

PREATTACK AND POSTATTACK INVENTORIES OF CANNED AND DRIED MILK PRODUCTS
(Bernalillo County)

	Wholesalers	Restaurants and Institutions	Retailers	Consumers	Total Inventory
Canned and evaporated milk					
Preattack					
1,000 pounds	158	23	182	205	568
1,000 gal whole milk	38	6	.44	49	137
Weeks	.13	.02	.15	.17	.47
Postattack					
1,000 pounds	60.5	1.3	7.7	12.5	82
1,000 gal whole milk	14.5	0.3	1.9	3.0	19.7
Weeks	.07	*	*	.02	.09
Dried milk products					
Preattack					
1,000 pounds	99	4	29	92	224
1,000 gal whole milk	90	3	26	83	202
Weeks	.30	.01	.09	.28	.68
Postattack					
1,000 pounds	38	0.2	1.2	5.6	45
1,000 gal whole milk	34.6	0.2	1.1	5.1	41
Weeks	.15	*	*	.03	.18
Total supply canned and dry milk products					
Preattack					
Weeks	.43	.03	.24	.45	1.15
Postattack					
Weeks	.22	*	*	.05	.27

* Less than .01 week.

In view of the difficulty of producing milk in the immediate postattack period and the paucity of fluid milk stocks expected to survive the Sanida burst (see Table 14), the availability of acceptable whole milk substitutes merits investigation. The most common whole milk substitutes in use today are canned and dried milk products. The preattack and postattack availability of these products in Bernalillo County is summarized in Table 15. This table shows that the county's postattack inventory of canned and dried milk products totals 0.27 weeks, or roughly two days. While this inventory is substantially larger than the surviving fluid milk supply, it is hardly sufficient to cover the time lapse before large scale fluid milk production can be resumed locally. The relative durability of canned and dried milk products, however, suggests the possibility of stockpiling these items in the preattack period. The desirability of such a stockpile is particularly evident in Bernalillo County, since the inventory of fluid, dried and canned milk products following the 1965 attack would not last until production resumed, even if the distribution of these products were to be restricted to children under 12 and nursing mothers.

Eggs

Chickens are the most radioresistant of the livestock commonly providing food for Albuquerque tables. As a result, 89.6 percent of Bernalillo County's poultry supply may be expected to survive the August 24 attack. Unfortunately, local poultry are able to fill only 23 percent of the county's postattack egg requirements. The remainder of these requirements must be met by out-of-state suppliers and by poultry farms in other New Mexico counties. The survival of the sources normally supplying Albuquerque's egg demands is tabulated in Table 16.

Table 16

SURVIVAL OF SHELL EGG FARMS SERVING BERNALILLO COUNTY CONSUMERS

Source	Yearly Preattack Supply (Million Dozens)	Survival Percentage	Yearly Postattack Supply (Million Dozens)	Yearly Postattack Demand (Million Dozens)
Out of state poultry farms	5.00	69.5	3.48	
New Mexico poultry farms	1.17	97.5	1.14	
Albuquerque poultry farms	1.73	89.6	1.55	
	7.90	78.0	6.17	6.75

Although Table 16 shows a slight deficiency in the ability of preattack shell egg suppliers to meet the local demand for egg products in the first postattack year, this deficiency will be more than overcome by the availability of manufactured egg products. Local residents will experience a shortage of eggs immediately following the attack, as less than one day's supply is expected to survive the effects of the Sandia burst. Since shell eggs require no processing and can be marketed directly by the poultry farmer if the need arises, however, this initial shortage should be overcome by the time Albuquerque survivors have consumed their shelter stocks. The repair and maintenance of transportation links with such states as California, Nebraska, and Iowa should assure local survivors of a continuing supply of sufficient eggs and egg products to meet postattack requirements.

Cereals and Cereal Products

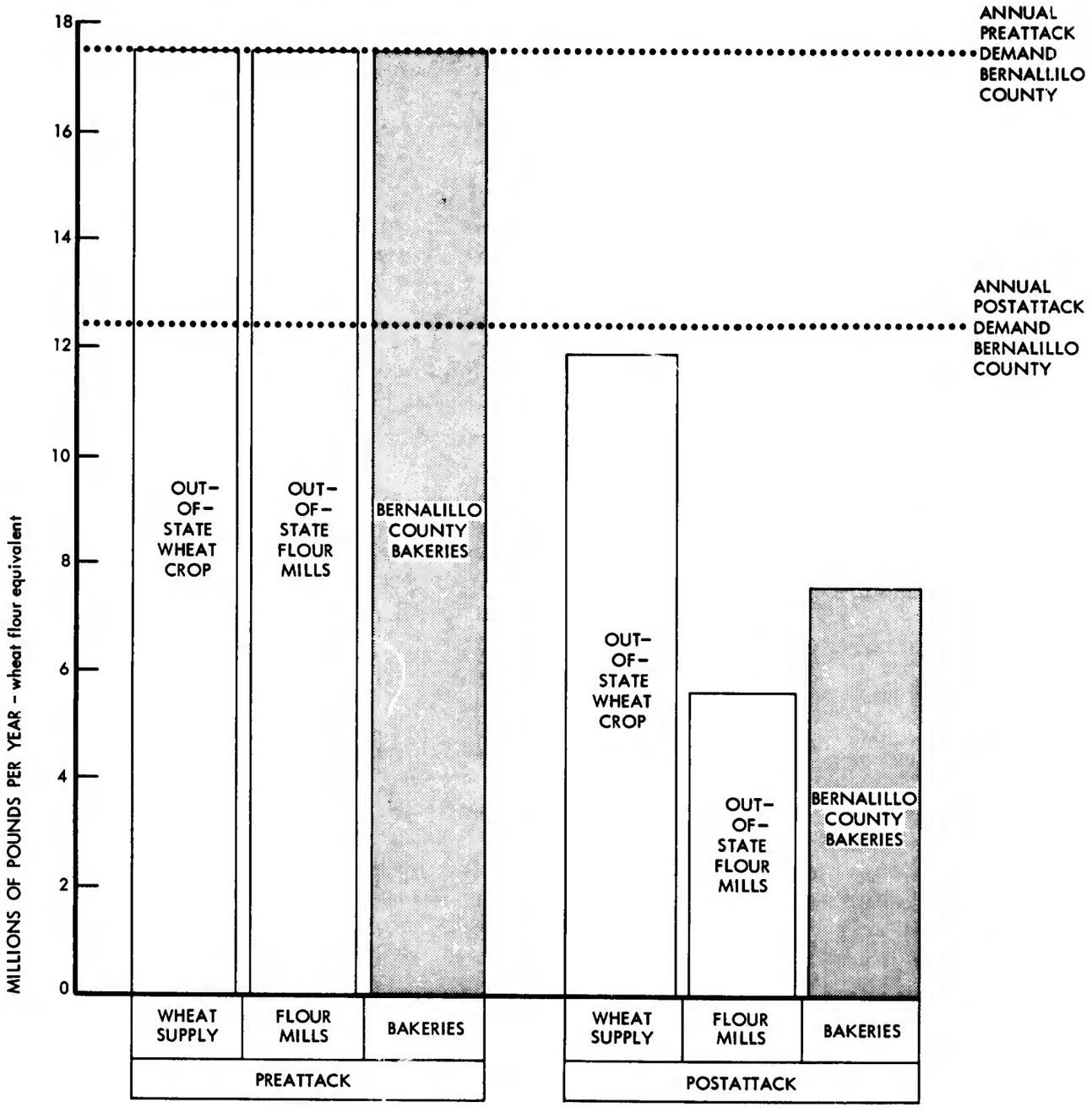
Bread is the most important cereal product used as food in the United States. Figure 20 shows the survival of the wheat crop, flour mills, and bakeries in the distribution chain supply bread to Bernalillo County consumers. This figure reveals severe bottlenecks at the processing level of the distribution system. The system constriction closest to the Albuquerque consumer is the low postattack capability of Bernalillo County bakeries. Only one local bakery can be expected to survive the ravages of the Sandia burst. Although this bakery is Albuquerque's largest, it is capable of supplying only 63 percent of the city's post attack consumption needs. The bakery management, which is not affected by the attack, might decide to raise this production level once the ovens begin operating in the postattack period. Even with an increased output, however, the one month repair period required to restart the bakery and the difficulty of obtaining flour from preattack sources make it unlikely that the single surviving bakery will be able to meet local demands for bread in the first postattack year.

The relatively low level of postattack flour production depicted in Figure 20 reflects heavy damage to the Denver mills currently supplying most of the flour used by Albuquerque bakers. A separate study (Reference 8) has estimated that 64 percent of the flour milling capability in the nation at large could be expected to survive an attack slightly heavier than the Five-City attack. This general survival capacity is much higher than that of the specific Denver mills. Hence, it is likely that the surviving Albuquerque bakery will be able to find an alternate supplier of flour following the resumption of operations.

In addition to flour, the chief ingredients of bread are water, yeast, sugar and salt. Of these ingredients, yeast is the most vulnerable

Figure 20

SURVIVAL OF WHEAT SUPPLY, FLOUR MILLS, AND BAKERIES PROVIDING BREAD FOR BERNALILLO COUNTY CONSUMERS



to nuclear attack. Bakeries prefer to use an inexpensive, but perishable compressed yeast that must be kept under refrigeration and replenished every few days. Reference 1 reports that there are only 16 compressed yeast manufacturers in the United States, with only four located west of the Mississippi. At least two of the plants nearest to Albuquerque may be expected to survive the Five City attack, so that yeast supplies should not be denied to the surviving local bakery once interstate transportation and electricity for refrigeration has been restored. Small stockpiles of dry yeast would help reduce yeast shortages in the immediate postattack period.

Reference 12 estimates that 68 percent of the nation's wheat crop could be harvested following an attack of a magnitude comparable to the Five-City attack. Although Figure 20 shows that a 68 percent harvest, if distributed through normal preattack channels, would fall slightly short of the postattack needs of Bernalillo County, this calculation ignores the reserves of wheat available from preattack harvests. In an analysis of postattack wheat resources based on 1960 storage statistics, Reference 8 concluded that the demands of the population for wheat in the first postattack year could be filled by surviving wheat stocks without drawing on any wheat harvested in the postattack period. The attack considered in this analysis was much heavier than the Five-City attack. Although twice as much surplus wheat was stored in the United States in 1960 as in 1965, the 1965 stocks, even at their lowest point, never represented less than half the harvest of the previous year. Thus, there would be no danger of a wheat shortage following the 1965 Five-City attack. In spite of the existence of ample wheat surpluses, damage to flour mills in neighboring states and to bakeries in Bernalillo County will cause bread shortages in Albuquerque throughout the first postattack year. These shortages will be particularly acute in the months immediately following the attack.

A portion of the postattack demand for grain products will be filled by manufactured cereal products that are more durable than bread. Crackers, breakfast cereals, and prepared flour mixes are examples of such products. Unfortunately, Albuquerque is almost entirely dependent upon out-of-state processors and suppliers for its stock of manufactured cereal products. Since Table 14 shows that less than a week's supply of all cereal products is available in Albuquerque local distribution system after the attack, this reliance on out-of-state resources will undoubtedly cause shortages in the immediate postattack period.

An earlier study (Reference 8) has estimated that 91 percent of the nation's cereal makers, 47 percent of its cracker producers and 50 percent of its manufacturers of prepared flour mixes could expect

to survive an attack of greater magnitude than the Five-City attack. These figures suggest that manufactured cereal products will be available to Albuquerque survivors. They will not be available in sufficient quantities to overcome local bread shortages, however, and slight deficits in the overall requirements for cereals and cereal products can be expected throughout the first postattack year.

Fruit and Vegetables

A review of the effects of fallout from the Los Alamos burst has shown that local fruit and vegetable crops will experience negligible radiation damage from the Five-City attack. Unfortunately, surviving local crops will not go very far toward meeting local postattack demand. Local and state farmers normally supply only eight percent of Albuquerque's demand for fruit and vegetables. Most of the local requirements for fresh fruits and vegetables are met by growers scattered throughout the nation. Reference 45 estimates that the national potential for producing fruits and vegetables following an attack slightly heavier than the Five-City attack would more than exceed the postattack requirements. Hence, Albuquerque residents should experience shortages of fresh fruits and vegetables only so long as postattack transportation is crippled.

Most of the stocks comprising the one-week supply of fruits and vegetables expected to survive the Sandia burst (see Table 14) are in processed form. Since Albuquerque residents also rely on out-of-state resources for processed fruits and vegetables, this one week supply will probably be exhausted before adequate reinforcements are received. The nearest sources of resupply are the Lubbock and El Paso warehouses that normally provide Albuquerque chain stores with processed foods. Since each of these cities is targeted in the Five-City attack plan, there will undoubtedly be some shortage of processed fruits and vegetables in Albuquerque in the initial postattack months. As in the case of fresh produce, transportation will be the critical factor in the supply of processed fruits and vegetables.

Food Fats and Oils

The commodity inventory statistics of Table 14 show that Bernalillo County residents may expect to have a 2-1/2 week supply of edible fats and oils available for consumption in the immediate postattack period. Since most of the county's supply of edible oils comes from the midwestern and southeastern portions of the United States, this buffer supply will

undoubtedly be exhausted before additional stocks reach Albuquerque. Local postattack supplies may be augmented by using animal fats produced by local meat processors. Additional emergency supplies might be obtained by churning otherwise unprocessable milk into butter.

There are two categories of processors in the vegetable oil industry--crushers and refiners. Neither type of processor is to be found in the state of New Mexico. Crushing factories that produce crude soybean and cottonseed oils tend to be located in the Midwest and Southeast near areas where soybeans and cotton are grown. Their dispersion makes them relatively invulnerable to nuclear attack. Refining plants are concentrated near the large population centers of five states: New Jersey, Illinois, Texas, Georgia, and California. Because of the tendency of refining plants to be located near population centers, it is anticipated that they will suffer significant damage in the Five-City attack. Consequently, shortages of edible fats and oils may be anticipated throughout the first postattack year.

The Midwest soybean crop, which is the nation's chief source of vegetable oil, may be relatively hard hit by a nuclear attack. References 45 and 20 predict that the survival of this crop after an attack of somewhat larger magnitude than the Five-City attack could range between 46 and 85 percent of its preattack level. Furthermore, national stocks of soybeans and edible oils would be comparatively low at the time of the Five-City attack. On August 24, 1965, soybean stocks and edible oil reserves represented only 3.4 percent and 7.5 percent of their respective yearly production levels (Reference 74). These unfavorable statistics are lightened by the fact that the United States' position as an exporter of fats and oils has led this nation to produce 135 percent of its own vegetable oil requirements in recent years. Even if no edible oils are exported during the first postattack year, however, refinery damage will undoubtedly cause shortages to exist. These shortages may be slightly offset by an increased use of such animal fats as lard and butter.

Potatoes

Because of its hardiness, its unique nutritive value, and its ability to substitute for both meat and cereal products, the potato is a particularly valuable postattack crop. The utility of the potato in times of war is a fact of history. From 1778 on, potatoes have played an important part in warfare in England, Ireland, and Continental Europe. In the American Civil War, the presence of scurvy in prison camps showed a high correlation with the absence of potatoes in prisoner's diets. In more recent wars, the potato has continued to be an important food source.

Reference 64 reports that:

> Potatoes are among the most reliable foods to insure man's survival during modern wars. This has been amply proved during the last two world wars. Potatoes are not easily destroyed by fire even in storage because they contain enough water to prevent them from burning. Potatoes in the field cannot be readily burned in contrast to grain crops such as wheat. This was well illustrated after the fighting had swept over Okinawa. The people could dig potatoes and survive after most other food supplies were eaten or destroyed.

The timing of the Five-City attack ensures that potatoes will be immediately available to residents of Bernalillo County. At the time of the attack, national stocks of the previous year's large fall crop (usually 75 percent of the nation's production) are exhausted, so that the chief local source of potatoes is New Mexico's annual commercial crop. The largest contributor to this crop is Torrance County, immediately to the southeast of Bernalillo County. The Torrance County crop, which is unaffected by the Five-City attack, is ordinarily harvested between late August and early November. The potato production of Torrance County and other neighboring counties commonly approaches 20 million pounds during this period. Albuquerque survivors will require 6.75 million pounds of potatoes during the first three postattack months. The local harvest, therefore, is more than equal to these demands. Since potatoes require no processing moreover, the local crop will be immediately accessible to attack survivors. Thus, the two day supply of potatoes available to survivors in the immediate postattack period (see Table 14) can be augmented by New Mexico's commercial potato harvest before any shortages are felt.

Harvest of the large national fall potato crop normally begins in mid-September and continues through October. This harvest commonly supplies the nation with enough potatoes to last until the following summer. Reference 12 estimates that 76.2 percent of the national potato crop would survive an attack of slightly greater magnitude than the Five-City attack. The survival of this much of the national harvest, coupled with the immediate availability of the local crop, guarantees that Albuquerque survivors will not lack potatoes at any time during the first postattack year.

The New Mexico late summer and fall potato crop represents less than two percent of the national production during this period. Nonetheless, this relatively small New Mexico crop would be vitally important to the citizens of Albuquerque in the period immediately following the Five-City attack. In addition to filling the demands of local survivors for potatoes

during the first three months following the Sandia burst, a portion of this crop might also be used as a substitute for meat and cereal products in the immediate postattack period. In discussing emergency food consumption standards, Reference 88 notes that 2-3/4 pounds of potatoes would provide the same food elements as a pound of meat, while five pounds of potatoes would serve as an acceptable substitute for one pound of cereal products. The New Mexico potato harvest following the Five-City attack would produce roughly 18 million pounds of potatoes in excess of the demands of Albuquerque survivors and other New Mexico citizens normally dependent upon this supply. This excess would ordinarily make its way into national marketing channels in competition with Idaho and Colorado potatoes. In view of the relatively small impact of New Mexico potatoes on the national market, however, and the severe local food shortages to be expected immediately following a nuclear attack, this excess might best be employed locally to alleviate postattack commodity shortages. At the quoted substitution rate, that portion of the New Mexico potato crop normally sold out of state would represent a 3.5 week supply of cereal or an 8.5 week supply of meat to Albuquerque residents. In view of the local deficiency of cereal products predicted in the immediate postattack period, Bernalillo County survivors would be well advised to use as much as possible of the excess crop as a cereal substitute.

Although no processing is necessary in the case of the potato and most potatoes reach the consumer in unprocessed form, it is worth noting that 76.4 percent of Bernalillo County's preattack potato processing potential is expected to survive the Five-City attack. This figure reflects the survival of the plant and management of three local potato chip manufacturers capable of processing roughly 5.8 million pounds of potatoes in the first postattack year. This processing capability would have the effect of offering a certain dietary variety to local survivors who will be heavily dependent on potatoes for sustenance in the early postattack months.

Sugars and Sweets

Because of its heavy reliance on imported cane sugar and the tendency of cane sugar refineries to be concentrated in large port cities, the U.S. sugar industry is extremely vulnerable to nuclear attack. Of the twenty-four cane sugar refineries in the mainland United States, only six are located in cities not targeted in the Five-City attack. The domestic beet sugar industry is much less vulnerable. Reference 12 estimates that 74.3 percent of the national beet sugar crop would survive an attack slightly heavier than the Five-City attack. Since beet sugar refineries are distributed in accordance with the Nation's crop, this figure may also be used as an estimate of postattack beet sugar processing

capability. In all, roughly 40 percent of the total United States preattack cane and beet sugar refining capability may be expected to survive the Five-City attack. Even if raw cane sugar imports were to be unimpaired by the attack, therefore, domestic sugar production would be severely curtailed in the first postattack year.

Although New Mexico has a negligible sugar beet crop and no refining capability, neighboring Colorado ranks third in the nation in sugar beet production and has more sugar beet refineries than any state in the country. The bulk of Colorado's harvest takes place between early October and mid-November. It is estimated that 73.9 percent of Colorado's crop and 79 percent of its processing capacity will survive the Five-City attack. Because of the proximity of Colorado sugar production, New Mexico uses a higher percentage of beet, as opposed to cane, sugar than the rest of the country. Consequently, New Mexico counties will be less affected by the relatively high incidence of damage to cane sugar refineries.

At the local level, Table 14 shows that Albuquerque survivors can expect to have in excess of a 4-1/2 week supply of sugar available after the Sandia burst. Unfortunately, a large portion of this supply is in the hands of local bakers and soft drink bottlers. The crippled post-attack condition of local bakeries has been discussed earlier in this chapter. Heavy damage is also suffered by local soft drink bottlers. Roughly 39 percent of Albuquerque's soft drink bottling industry is expected to survive the Sandia burst. This relatively low figure may be lowered even further to 27 percent in the early postattack period by the lack of adequate management capabilities. Since soft drink bottlers tend to depend on intricate, automatic, special-purpose machinery, even those plants surviving the attack will be unable to resume operation immediately. The heavy damage suffered by Albuquerque bakers and bottlers, coupled with the complete destruction of local candy manufacturers, makes it unlikely that the two weeks' supply of sugar held by surviving processors will be immediately available for consumption following the August 24 attack.

Without considering the two week supply of sugar held by local processors, surviving sugar stocks in the remainder of the Albuquerque distribution pipeline will last local residents approximately 2-1/2 weeks. Shortages will then be experienced until early October, when the Colorado beet sugar crop is harvested and processed. By this time, however, because of the heavy damage to the U.S. cane sugar refineries, national processors will have nearly exhausted their sugar supplies. At the retail level, this damage will be reflected in shortages of such foods as bakery products, sweetened condensed milk, canned fruits, soft drinks, jams, jellies. and confectionery products. Since most sugar

is consumed in one of these forms, Albuquerque residents will experience deficiencies in their sugar requirements throughout most of the first postattack year. A judicious adjustment of sugar beet production quotas in the light of the postattack situation would help to alleviate this deficiency in the second year following the attack.

Summary

At some time during the first month following the Five-City attack, Bernalillo County survivors may anticipate severe shortages of every commodity except potatoes. Severe shortages of meat and eggs should be alleviated approximately two weeks after the attack, as the local production of these commodities can be resumed with relative ease. Local survivors will be heavily dependent on out-of-state transportation connections for supplies of fruits and vegetables, fats and oils, and sugars and sweets. Although severe shortages of these items should not persist more than two weeks after the depletion of preattack inventories, slight shortages may be anticipated throughout the first postattack year. Heavy damage to local bakeries, the destruction of the mills that usually provide flour for these bakeries, and the reliance upon out-of-state sources for manufactured cereal products will cause severe shortages of cereal products to exist for approximately two months following the attack. Although shortages of mass-produced bread will persist throughout the first postattack year, these shortages will be slightly offset in the long run by the availability of more durable cereal products. The single commodity in shortest supply following the attack will be fluid milk. Heavy damage to local processors, aggravated by the depletion of local dairy herds due to radiation sickness and mastitis, may cause severe milk shortages to exist for as long as four months. It is unlikely that preattack consumption levels will be attained at any time during the first postattack year.

Because of the presence of shelter stocks that are capable of providing survivors with two weeks sustenance, however, the shortages described in the preceding paragraph will not be immediately critical. Nevertheless, these stocks alone will not be sufficient to sustain the population during the period between the depletion of preattack commodity inventories and the times at which the distribution systems supplying the various commodities can reasonably be expected to resume functioning.

It should be emphasized that this description of the plight of Albuquerque survivors is somewhat exaggerated by the combined use of conservative damage assessment techniques and liberal estimates of the number of survivors. Even if allowances are made for biases,

however, the ability of preattack resources to meet postattack demands could be expected to be marginal at best.

The plight of Albuquerque survivors in the immediate postattack period is emphasized by the geographical isolation of the city itself. Albuquerque is not unique in this isolation. As modern transportation capabilities and the competitive investment in warehouses and inventory required in the food distribution industry have increased, food distributors have tended to serve larger and larger geographic areas with smaller and smaller local operating inventories. Consequently, more and more cities are becoming isolated from substantial quantities of stored foods. Hence the postattack experience of Albuquerque, in which working food inventories in the wholesale and retail supply pipeline disappear within a matter of days under emergency conditions, could be expected to be repeated in many U.S. cities. It follows that the development of an emergency distribution and resupply capability would be more important to the survival of these cities than a wistful reliance upon preattack pipeline inventories.

In the case of Albuquerque, an emergency supply capability might best be created by stockpiling critical items during the preattack period. The potential importance of federal shelter stocks immediately after an attack has already been noted. These supplies should be supplemented, however, by the maintenance of inventories of durable commodities at a short distance from the city. The desirability of stockpiling canned and dried milk products in the preattack period has been discussed earlier. Other items which might profitably be stored would include cheese, crackers, canned fruits and vegetables, sugars, and vegetable oils. The operational survival plan for Bernalillo County outlined by the Office of Civil Defense in 1959 (Reference 51) suggests that the nearby cities of Moriarty, Bernalillo, Corres, Bernardo, and Grants might function as supply dumps in the event of a nuclear attack. (These cities were ideally selected from the standpoint of the present study as none of them would be adversely affected by blast overpressure from the proposed Five-City attack pattern.) Reference 51 also implies that the supply dumps could be stocked from supplies already in the distribution pipeline at the time of the first warning. In view of the relatively low working level of local pipeline inventories and the frenzied atmosphere anticipated in the warning period, it might be better to begin amassing stockpiles as soon as possible.

Within six weeks after the Five-City attack, the supply pipelines for all commodities, except milk, should be reopened and functioning at various levels of their preattack capabilities. The presence of emergency stocks in supply dumps outside of Albuquerque would provide an important

source of sustenance to local survivors in the critical period before these pipelines are reopened. It is extremely doubtful that existing shelter stocks and preattack pipeline inventories could be made to meet the needs of all survivors throughout this period. Moreover, shortages immediately following the attack could lead to hoarding, looting, and theft. Such social disorder would prevent the equitable distribution of supplies and increase the severity of postattack shortages. Without an emergency supply capability beyond that presently available in Albuquerque, however, such shortages will be unavoidable, and local citizens will have a very difficult time finding adequate nourishment until preattack supply pipelines are reopened.

Appendix A

BERNALILLO COUNTY PROCESSORS

BERNALILLO COUNTY PROCESSORS

No.	Name	Address	SIC Code	Employees
	100: MEAT AND MEAT ALTERNATES			
101	Karler Packing Co.	Box 1005, S.E. Broadway	2011	10-19
102	Schwartzman Packing Co.	Box 1358, 3301 2nd St., S.W.	2011	76-99
103	Stephens Meats, Inc.	2500 Coors Blvd., S.W.	2011	10-19
104	Palmer Packing Co.	2890 Candelarie, N.W.	2011	5-9
105	Kingston Meat & Provision Co.	922 3rd Ave., N.W.	2013	5-9
106	Las Lomas Meat Co.	529 Adams, N.E.	2013	10-19
107	Swift & Company	2200 Zearing Ave., N.W.	2013	10-19
	200: MILK AND DAIRY PRODUCTS			
201	Darrow Ice Cream	501 Armo, S.E.	2024	20-49
202	Creamland Dairy	1911 Second St., N.W.	2026	100-249
203	McIlhaney's Dairy	6615 Edith Blvd., N.E.	2026	5
204	Preston Dairy Products Co.	5802 Edith Blvd., N.E.	2026	5
205	Swendson Farm Dairy	1609 Tapia Blvd., S.W.	2026	5-9
206	Thatcher's Dairy	7424 Edith N.E.	2026	10-19
207	Valley Gold Dairies	1710 Fourth N.W.	2026	100-249
	300: EGGS			
	None located in Bernalillo County			
	400: CEREALS AND CEREAL PRODUCTS			
401	Cottage Bakery	2004 Central, S.E.	2051	50-99
402	Holsum Bakers of Albuquerque	901 Second, S.W.	2051	20-49
403	Jill's Inc.	1008 Coal, S.E.	2051	100-249
404	Martin's Bakery	4119 Prospect, N.E.	2051	20-49
405	Mead Bakery	717 Coal Ave., S.E.	2051	20-49
406	Nob Hill Bakery	3500 Central, S.E.	2051	10-19
407	Rainbo Baking Co.	111 Montano, N.E.	2051	100-249
408	Swell Bakery	536 Truman, N.E.	2051	5-9
409	Tasty Bakery	9635 Menaul, N.E.	2051	10-19
410	Union Baking Co.	313 First, S.W.	2051	10-19

No.	Name	Address	Sic Code	Employees
		500: FRUITS AND VEGETABLES		
		None located in Bernalillo County		
		600: FOOD FATS AND OILS		
		None located in Bernalillo County		
		700: POTATOES		
701	Crispys Potato Chip Co.	Box 6385, 10002 2nd, N.W.	2099	10-19
702	Nalley's Inc.	2500 Gibson Blvd., S.E.	2099	20-49
703	Redi Spuds	1202 Fourth, S.W.	2099	5
704	Zip Foods (Div. Morton Foods)	3524 Broadway, S.E.	2099	20-49
		800: SUGARS AND SWEETS		
801	Allen Candy Co.	3015 Third St., N.W.	2071	5
802	Alyce Kimmel Candies	1919 Old Town Rd., N.W.	2071	5
803	B&H Co., Inc.	7001-03 Lomas, N.E.	2071	5
804	Thelma Lu's Candy	5823 Lomas, N.E.	2071	20-49
805	Canada Dry Bottling Co. of New Mexico	604 Menaul, N.W.	2086	20-49
806	Coca-Cola Bottling Co.	205 Marquette, N.E.	2086	20-49
807	Pepsi-Cola Bottling Co.	2121 Claremont, N.E.	2086	20-49
808	Royal Crown Bottling Co.	1506 Candelane Rd., N.E.	2086	20-49
809	7-Up Bottling Co.	2101 Claremont, N.E.	2086	20-49
		900: MISCELLANEOUS		
901	New Mexico Dog Food Co.	Box 1250	2042	5-9
902	Onate Feed Co.	Box 3052, S.E. Broadway	2042	5-9
903	Ravel Brothers, Inc.	525 Second, S.W.	2042	10-19
904	Barabe Sauces	108 Cornell, S.E.	2035	5-9
905	C & S Packing Co.	639 Kinley, N.W.	2035	5
906	Derman's Delicacies	2923 Girard, N.E.	2035	5-9
907	Boca's Mexican Kitchen	4021 Central, N.E.	2037	10-19
908	Best Mexican Foods	1307 4th, S.W.	2099	10-19
909	El Encanto	1224 Airway Rd., S.W.	2099	10-19
910	El Modelo Tortilla Factory	1715 Second, S.W.	2099	5-9
911	Sanitary Tortilla Factory	411 Fourth, S.W.	2099	5-9

BERNALILLO COUNTY WHOLESALERS

No.	Name	Address	SIC Code
	100: MEAT AND MEAT ALTERNATES		
101	D&D Poultry Inc.	222 Candelaria Rd., N.E.	5044
102	Duke City Meat Co.	1920 1 N.W.	5047
103	Jaramillo's Meat Market	912 Broadway, N.E.	5047
104	Meat Block	1439 Eubank Blvd., N.E.	5047
105	Randy's Quality Frozen Meat	601 Commercial, N.E.	5047
	200: MILK AND DAIRY PRODUCTS		
201	Blue Ribbon Dairies, Inc.	3710 Edith Blvd., N.E.	5043
202	Foremost Dairies, Inc.	815 Broadway, N.E.	5043
	300: EGGS		
301	Albuquerque Cackleberries	229 Valleyhigh Ave., S.W.	5044
302	Ark Valley Co-op Dairy Assoc.	600 1st, N.W.	5044
303	Broadway Poultry Inc.	2225 4th, N.W.	5044
304	Harris Poultry Farms, Inc.	Rt. 1, P.O. Box 750 Broadway, S.E.	5044
305	Market Produce Co. of Albuquerque	1707 Broadway, N.E.	5044
306	Ralson Purina Co., Poultry Prod. Div.	2812 Girard Blvd., N.E.	5044
307	Wicker Inc.	1521 Broadway, N.E.	5044
	400: CEREALS AND CEREAL PRODUCTS		
401	Nabisco		5049
	500: FRUITS AND VEGETABLES		
501	Basila, Ralph Products Co., Inc.	301 Stanford Dr., S.E.	5048
502	Hutchinson Fruit Co., Inc.	114 Tijeras Ave., N.E.	5048
503	New Mexico Produce Dist.	600 1st, N.W.	5048
504	Romney Produce Co.	1707 Commercial, N.E.	5048

No.	Name	Address	SIC Code
	600: FOOD FATS AND OILS		
	None located in Bernalillo County		
	700: POTATOES		
701	Frito-Lay Inc.	2816 Girad Blvd., N.E.	5049
	800: SUGARS AND SWEETS		
801	Commercial Marketing Corp.	299 Industrial Ave., N.E.	5045
802	Ghalson Bros. Candy Co.	104 Summer Ave., N.W.	5045
803	Harwell, J. Vernon	2113 San Mateo Blvd., N.E.	5045
804	Manzano Distributing Co.	301 Industrial Ave., N.E.	5045
805	Rocky Mountain Wholesale Co.	1110 1st, N.W.	5045
	900: MISCELLANEOUS		
901	Associated Grocers	5600 2nd, N.W.	5042
902	Barabe Food, Inc.	108 Carnell Dr., S.E.	5042
903	Caribe Distributing Co.	401 Maple, S.E.	5042
904	Denison Coffee Co.	640 Oak, S.E.	5042
905	H & R Wholesale Co.	2501 Commercial, N.E.	5042
906	Jafar Brokerage Co.	1022 2nd, S.W.	5042
907	Kimball-Albuquerque Co.	1239 Bellamah, N.W.	5042
908	New Mexico Grocery Co.	106-108 Central Ave., S.E.	5042
909	New Mexico Sales Co.	5911 4th, N.W.	5042
910	R & S Brokerage Co.	5508 Guadalupe Trl., N.W.	5042
911	Valley Distributing Co.	2819 Second, N.W.	5042
	1000: REFRIGERATED WAREHOUSING		
1001	Albuquerque Railways Ice & Service Co.	601 Commercial, N.E.	4222
1002	C & B Frozen Food Lockers	1217 Bridge, S.W.	4222
1003	New Mexico Cold Storage	1235 Aspen, N.W.	4222
1004	Quality Foods	523 Rio Grande Blvd., N.W.	4222
1005	Vena's Frozen Food Co.	2004 Central, S.E.	5049

Appendix C

PROCESSOR-WHOLESALER DAMAGE SUMMARY

Table C-1

PROCESSOR-WHOLESALER DAMAGE SURVEY

Facility	Blast Range (1 000 meters)	Probability of Destruction by Fire	Destroyed by Fire	Structure	Equipment	Repair Time (days)	First Year Production Capability (percent)	Perishable (% Destroyed)	Nonperishable (% Destroyed)	Damage Summary
Processors										
100 Meat and Meat Alternates										
101 Karler Packing Co.	13.0	0.00	No	M	M	30	90	100	-	M
102 Schwartzman Packing Co.	13.4	0.00	No	L-M	M	30	90	100	-	M
103 Stephens Meats Inc.	18.0	0.00	No	L	L	10	100	75	-	L
104 Palmer Packing Co.	18.2	0.13	No	L	L	10	100	75	-	L
105 Kingston Meats Provision Co.	13.5	0.99	Yes					100	-	F
106 Las Lomas Meat Co.	8.5	1.00	Yes					100	-	F
107 Swift and Co.	15.7	0.24	No	L	N	10	100	50	0	N-L
200 Milk and Dairy Products										
201 Darrow Ice Cream	12.6	0.95	Yes					100	-	F
202 Creamland Dairy	13.8	0.27	Yes					100	-	F
203 McIlhaney's Dairy	15.5	0.23	Yes					100	-	F
204 Preston Dairy Products, Inc.	14.5	0.00	No	L-M	M	30	90	100	-	M
205 Swendson Farm Dairy	16.2	0.19	No	M	M	60	80	100	-	M
206 Thatcher's Dairy	15.6	0.26	No	M	M	60	80	100	-	M
207 Valley Gold Dairies	13.9	0.26	No	M-H	H	150	50	100	80	H
300 Eggs										
400 Cereals and Cereal Products										
401 Cottage Bakery	Out of Business									
402 Holsum Bakers	13.1	0.98	Yes					100	100	F
403 Jill's Inc.	11.9	0.38	Yes					100	100	F
404 Martin's Bakery	10.3	0.53	No	H	H	U	0	100	80	H
405 Mead Bakery	12.2	0.93	Yes					100	100	F
406 Nob Hill Bakery	9.2	0.96	Yes					100	100	F
407 Rainbo Baking Co.	14.9	0.00	No	L	L-M	30	90	80	40	L-M
408 Swell Bakery	8.0	0.96	Yes					100	100	F
409 Tasty Bakery	7.4	1.00	Yes					100	100	F
410 Union Baking Co.	13.0	0.99	Yes					100	100	F
500 Fruits and Vegetables										
600 Food Fats and Oils										
700 Potatoes										
701 Crispys Potatoe Chip Co.	19.0	0.00	No	L-M	L	10	100	20	20	L
702 Nalley's Inc.	9.9	0.57	No	M-H	M-H	120	70	100	80	M-H
703 Redi-Spuds	13.3	0.98	Yes					100	100	F
704 Zip Foods	12.2	0.00	No	M-H	H	120	70	100	80	M-H

Table C-1 (continued)

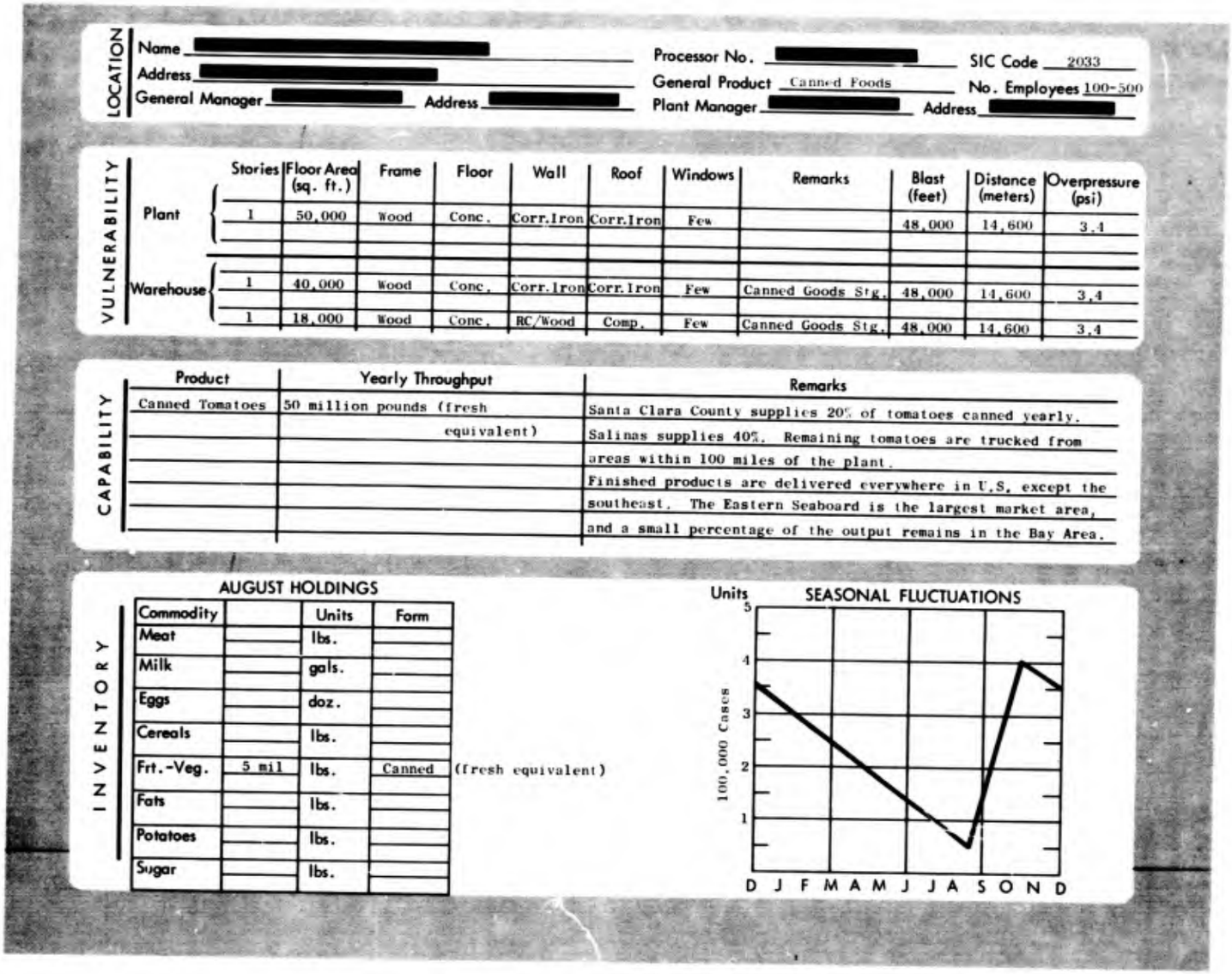
Facility	Blast Range (1,000 meters)	Probability of Destruction by Fire	Destroyed by Fire	Structure	Equipment	Repair Time (days)	First Year Production Capability (percent)	Perishable (% Destroyed)	Nonperishable (% Destroyed)	Damage Summary
Processors (continued)										
800 Sugars and Sweets										
801 Allen Candy Co.	14.2	0.35	Yes					-	100	F
802 Alyce Kimmel Candies	15.3	0.87	Yes					-	100	F
803 B & H Co.	6.8	1.00	Yes					-	100	F
804 Thelma Lu's Candies	7.7	0.96	Yes					-	100	F
805 Canada Dry Bottling Co.	14.5	0.76	Yes					-	100	F
806 Coca-Cola Bottling Co.	13.0	0.99	Yes					-	100	F
807 Pepsi-Cola Bottling Co.	12.0	0.00	No	L-M	M	30	90	-	50	M
808 Royal-Crown Bottling Co.	13.0	0.00	No	M	M-H	60	80	-	70	M-H
809 7-Up Bottling Co.	12.3	0.00	No	M	M-H	60	80	-	60	M-H
900 Miscellaneous										
901 New Mexico Dog Food Co.	19.0	0.00	No	L	L	10	100	50	-	L
902 Onate Feed Co.	13.5	0.00	No	M	M-H	60	80	-	50	M
903 Ravel Brothers, Inc.	13.1	0.98	Yes					-	100	F
904 Barabe Sauces	10.5	0.80	No	H	H	U	0	100	80	H
905 C & S Packing Co.	14.0	0.93	Yes					100	100	F
906 Derman's Delicacies	Out of Business									OB
907 Baca's Mexican Kitchen	8.7	0.96	Yes					100	100	F
908 Best Mexican Foods	13.3	0.89	Yes					100	100	F
909 El Encanto	14.7	0.79	No	M	M	30	90	100	70	M
910 El Modelo Tortilla Factory	13.0	0.88	Yes					100	100	F
911 Sanitary Tortilla Factory	13.3	0.00	No	M-H	M-H	90	70	100	80	M-H
Wholesalers										
100 Meat and Meat Alternates										
101 D & D Poultry, Inc.	12.3	0.00	No	H				100	-	H
102 Duke City Meat Co.	13.2	0.99	Yes					100	100	F
103 Jaramilla's Meat Market	12.9	0.99	Yes					100	-	F
104 Meat Block	5.6	1.00	Yes					100	-	F
105 Randy's Quality Frozen Meats	13.0	0.53	No	M				100	-	M
200 Milk and Dairy Products										
201 Blue Ribbon Dairies Inc.	13.6	0.00	No	M				100	-	M
202 Foremost Dairies Inc.	13.0	0.53	Yes					100	-	F
300 Eggs										
301 Albuquerque Cackleberries	13.6	0.29	No	M-H				100	-	M-H
302 Ark Valley Co-Op Dairy	13.1	0.99	Yes					100	-	F
303 Broadway Poultry Inc.	14.1	0.75	Yes					100	-	F
304 Harris Poultry Farms Inc.	4.0	1.00	Yes					100	-	F
305 Market Produce Co.	13.2	0.51	No	M				80	40	M
306 Ralston Purina Co.	11.8	0.00	No	H				100	-	H
307 Wicker Inc.	13.2	0.30	No	L-M				100	-	L-M

Table C-1 (concluded)

Facility	Blast Range (1,000 meters)	Probability of Destruction by Fire	Destroyed by Fire	Structure	Equipment	Repair Time (days)	First Year Production Capability (percent)	Perishable (% Destroyed)	Nonperishable (% Destroyed)	Damage Summary
Wholesalers (continued)										
400 Cereals and Cereal Products										
401 Nabisco	14.4	0.92	Yes					-	100	F
500 Fruits and Vegetables										
501 Basila Produce Co., Inc.	10.2	0.97	Yes					100	-	F
502 Hutchinson Fruit Co., Inc.	12.1	0.99	Yes					100	-	F
503 New Mexico Produce Dist.	13.1	0.99	Yes					100	-	F
504 Romney Produce Co.	13.2	0.51	No	H				100	80	H
600 Food Fats and Oils										
700 Potatoes										
701 Frito-Lay Inc.	11.9	0.00	No	H				-	80	H
800 Sugars and Sweets										
801 Commercial Marketing Corp.	14.4	0.00	No	M-H				-	50	M-H
802 Ghalson Bros. Candy Co.	13.4	0.99	Yes					-	100	F
803 J. Vernon Harwell	6.0	0.87	Yes					-	100	F
804 Monzana Distributing Co.	14.0	0.00	No	M-H				-	50	M-H
805 Rocky Mountain Wholesale Co.	13.2	0.99	Yes					-	100	F
900 General Groceries										
901 Associated Grocers	15.1	0.27	No	L				80	20	L
902 Barabe Foods Inc.	10.5	0.80	No	H				100	80	H
903 Caribe Distributing Co.	11.4	0.95	Yes					100	100	F
904 Denison Coffee Co.	11.9	0.38	No	H				-	60	H
905 H & R Wholesale Co.	13.7	0.00	No	M-H				-	50	M-H
906 Jafar Beverage Co.	13.7	0.91	Yes					-	100	F
907 Kimball-Albuquerque Co.	14.6	0.32	Yes					100	100	F
908 New Mexico Grocery Co.	12.9	0.99	Yes					-	100	F
909 New Mexico Sales Co.	15.9	0.27	Yes					-	100	F
910 R & S Brokerage Co.	16.4	0.21	No	L-M				-	30	L-M
911 Valley Distributing Co.	14.1	0.79	No	M				-	50	M
1000 Refrigerated Warehouses										
1001 Albuquerque Railways Ice & Service Co.	13.0	0.99	Yes					100	-	F
1002 C & B Frozen Food Lockers	14.6	0.79	Yes					100	-	F
1003 New Mexico Cold Storage	14.6	0.29	No	L-M				100	-	L-M
1004 Quality Foods	15.5	0.24	Yes					100	-	F
1005 Vena's Frozen Food Co.	10.9	0.42	No	H				100	-	H

Figure D-1

SAMPLE FOOD PROCESSOR DATA FORM



LOCATION

Name [redacted] Processor No. [redacted] SIC Code 2033

Address [redacted] General Product Canned Foods No. Employees 100-500

General Manager [redacted] Address [redacted] Plant Manager [redacted] Address [redacted]

VULNERABILITY

	Stories	Floor Area (sq. ft.)	Frame	Floor	Wall	Roof	Windows	Remarks	Blast (feet)	Distance (meters)	Overpressure (psi)
Plant	1	50,000	Wood	Conc.	Corr.Iron	Corr.Iron	Few		48,000	14,600	3.4
Warehouse	1	40,000	Wood	Conc.	Corr.Iron	Corr.Iron	Few	Canned Goods Stg.	48,000	14,600	3.4
	1	18,000	Wood	Conc.	RC/Wood	Comp.	Few	Canned Goods Stg.	48,000	14,600	3.4

CAPABILITY

Product	Yearly Throughput	Remarks
Canned Tomatoes	50 million pounds (fresh equivalent)	Santa Clara County supplies 20% of tomatoes canned yearly. Salinas supplies 40%. Remaining tomatoes are trucked from areas within 100 miles of the plant. Finished products are delivered everywhere in U.S. except the southeast. The Eastern Seaboard is the largest market area, and a small percentage of the output remains in the Bay Area.

INVENTORY

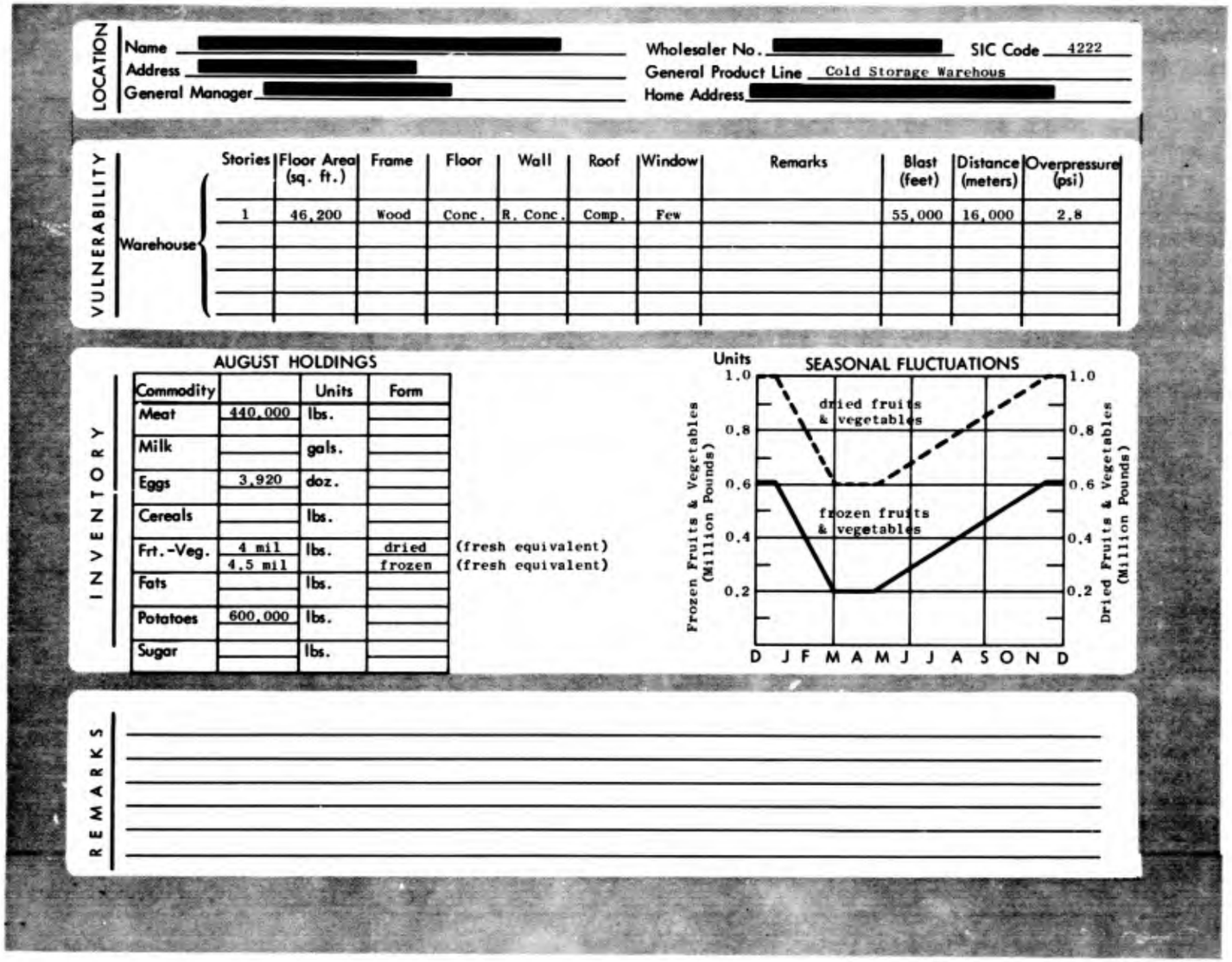
AUGUST HOLDINGS

Commodity		Units	Form
Meat		lbs.	
Milk		gals.	
Eggs		doz.	
Cereals		lbs.	
Frt.-Veg.	5 mil	lbs.	Canned (fresh equivalent)
Fats		lbs.	
Potatoes		lbs.	
Sugar		lbs.	

SEASONAL FLUCTUATIONS

Figure D-2

SAMPLE FOOD WHOLESALER DATA FORM



LOCATION

Name [redacted]
Address [redacted]
General Manager [redacted]

Wholesaler No. [redacted] SIC Code 4222
General Product Line Cold Storage Warehous
Home Address [redacted]

VULNERABILITY

	Stories	Floor Area (sq. ft.)	Frame	Floor	Wall	Roof	Window	Remarks	Blast (feet)	Distance (meters)	Overpressure (psi)
Warehouse	1	46,200	Wood	Conc.	R. Conc.	Comp.	Few		55,000	16,000	2.8

INVENTORY

AUGUST HOLDINGS

Commodity		Units	Form	
Meat	440,000	lbs.		
Milk		gals.		
Eggs	3,920	doz.		
Cereals		lbs.		
Frt.-Veg.	4 mil	lbs.	dried	(fresh equivalent)
	4.5 mil		frozen	(fresh equivalent)
Fats		lbs.		
Potatoes	600,000	lbs.		
Sugar		lbs.		

SEASONAL FLUCTUATIONS

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This report is the second in a series of local food distribution studies designed to forecast the availability and accessibility of critical foodstuffs in selected metropolitan areas in a nuclear postattack environment. The analytic technique employed in these studies uses local distribution diagrams, seasonal inventory data, and national production patterns to provide quantitative models of the preattack flow of individual commodities to consumers in the selected areas. Estimates of postattack commodity flow are obtained by applying appropriate damage assessment procedures to critical elements of the preattack distribution models. The application of this technique in the case of Albuquerque, New Mexico, reveals that local citizens might anticipate severe shortages of every important food commodity except potatoes in the period immediately following an attack of the pattern and magnitude considered in this study.

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Title: Postattack Availability and Accessibility: A Case Study
Author: John W. Billheimer

SUMMARY

This report is the second in a series of local food distribution studies designed to forecast the postattack availability and accessibility of critical foodstuffs in selected metropolitan areas.

To support a quantitative analysis of the food distribution system of Albuquerque, New Mexico, data are presented that depict the location, vulnerability, capacity, and inventory of local food producers, processors, wholesalers, retailers, restaurants, institutions, and consumers. Capacity and inventory data are presented on a commodity-by-commodity basis for the eight food groups of meat, milk, eggs, cereals and cereal products, fruits and vegetables, food fats and oils, potatoes, and sugars. These data are summarized in commodity-flow models that depict the normal distribution patterns followed by each food group in reaching local consumers.

Estimates of the effect of a postulated nuclear attack on food availability and accessibility in Albuquerque are obtained by applying appropriate damage assessment procedures to critical elements of the preattack commodity-flow models. The surviving distribution system for each commodity is examined for bottlenecks that might be caused by losses in production capability, processing capacity, labor productivity, supply availability, and transportation accessibility. Projected postattack inventories are compared with the U.S. Department of Agriculture's National Emergency Food Consumption Standards to determine the time periods during which local supplies of the selected commodities may be expected to meet the requirements of the Albuquerque survivors.

The network flow procedures described in this report predict severe shortages of every important food commodity except potatoes in the city of Albuquerque immediately following the hypothetical attack. Although meat and egg shortages will be comparatively short-lived, severe shortages of fluid milk and cereal products may be expected to persist for as long as two months following the attack. These shortages, coupled with Albuquerque's historical reliance on out-of-state sources of supply and the absence of an adequate emergency resupply capability within the city itself, mean that local citizens would find it extremely difficult to obtain an adequate nutritional balance before preattack supply pipelines are reopened.

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13. ABSTRACT

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